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A R M S T R O N G L A B O R A T O R Y

EVALUATION OF THE EFFECTS OF SWEDISH FLIGHT HELMETS ON MANIKIN RESPONSE DURING +Gz IMPACT ACCELERATIONS

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This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

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13. ABSTRACT *(Maximum 200 words)*

Swedish helmets 113-B and 116 were fitted to a large Advanced Dynamic Anthropomorphic Manikin (ADAM) and subjected to impacts of 8, 10, 15, and 20 G in the +z axis on the Armstrong Laboratory vertical deceleration tower, with neck loading data recorded. Laboratory tests were also performed in order to determine the mass properties of the helmets. The data were analyzed in order to determine the structural integrity and loading effects of the helmets, and the results compared to similar data obtained from tests with USAF HGU-26/P and HGU-55/P helmets. The results indicated that the two Swedish helmets generated significantly less neck compression loading than the two USAF helmets with respect to their relative weights. In addition, the HGU-26/P generated greater neck shear loading than the other three helmets. Variations in the centers of gravity of the helmets as well as the tighter fit of the Swedish helmets could have contributed to the differences among the helmets.

14. SUBJECT TERMS

113-B Helmet	Large ADAM Manikin	Neck Shear Force
116 Helmet	Neck Compression Force	Mass Properties

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PREFACE

The impact tests described in this report were accomplished by the Escape and Impact Protection Branch, Biodynamics and Biocommunications Division of the Armstrong Laboratory (AL/CFBE) at Wright-Patterson Air Force Base, Ohio. Facility and engineering support were provided by DynCorp under contract F33615-91-C-0531, and Systems Research Laboratories under the Engineering Services Contract. Flight helmets and technical support for the Swedish helmets were provided by the Swedish Air Force.

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INTRODUCTION

Background

Recent designs of night vision goggles and helmet mounted display systems are increasing the weight of the conventional helmet as well as shifting its center of mass. Recent studies at Armstrong Laboratory have investigated the effect of this variation in helmet mass properties on the dynamic responses of both human subjects and manikins in order to determine safe limits for helmet design. The Swedish helmet 113-B was of particular interest due to the combination of its heavy weight of 5.53 lbs and the large amount of operational ejection data supplied by the Swedish Air Force (1).

Objectives

The primary objective of this study was to accumulate manikin dynamic response data based on impact tests using Swedish helmets, as well as to determine the mass properties of the helmets. The results will be used to evaluate the Swedish helmets in comparison to USAF helmets, and to assist in the establishment of head/neck criteria (2) for helmet mounted systems.

METHODS

Facilities and Equipment

All tests were conducted on the Armstrong Laboratory Vertical Deceleration Tower (VDT) using the VIP seat fixture with the seat-back positioned at an angle of 0 degrees with respect to the +Gz acceleration vector. Metering pin 102 was used to control the deceleration vector. A head rest provided head support during the tests, and a restraint harness with lap belt was pretensioned at 20 +/- 5 lbs at each attachment point prior to each test. Additional straps were used to maintain the initial position of the manikins' ankles and thighs during the free-fall phase of the tests. A more complete description of the facility and equipment can be found in Appendix A.

Test Subject

All impact tests were performed using a large production Advanced Dynamic Anthropomorphic Manikin (ADAM). The large ADAM anthropometry design approximates the 97th percentile of military flying personnel (3).

Instrumentation and Data Processing

Accelerometers and load transducers were mounted to the seat fixture. The accelerometers included both linear and angular types. The load transducers included fixed load cells, triaxial load cells, and load links. Carriage velocity was measured with a tachometer attached to an aluminum wheel on the carriage in contact with the track wheel. The large ADAM manikin contained triaxial linear accelerometers mounted in the head and chest, and six-component load cells mounted in the head/neck. Data were collected over a period of four seconds by an automatic data acquisition and control system (ADACS), which also handled signal conditioning, filtering, and digitization (1000 samples/sec). The digitized data were transmitted through a whip cable to the computer room for storage and processing by a VAX computer system. Test data were reviewed immediately after each test by using a "quick look" scan routine which produced plots of data over time. A list of ADACS channel sensitivities allowed conversion of the data to engineering units. More detailed information on the instrumentation and data processing can be found in Appendix A.

Motion Analysis Data

Motion analysis data were collected during each impact test using two infrared detection cameras that recorded the

position of infrared targets (LEDs) at high-speed (500 samples/sec). The cameras were mounted on the test fixture at oblique and right angles to the manikin. The targets were mounted on the seat, carriage assembly, and manikin. The data consisted of displacement time-histories of the targets. Slow motion video coverage was also available through a Kodak recording system and on-board camera which provided immediate playback of the impact tests. More detailed information on the motion analysis system can be found in Appendix A.

Helmet Testing

The two Swedish helmets used were the 113-B (Figure 1), weighing 5.53 lbs, and the 116 (Figure 2), weighing 3.55 lbs. Both helmets were equipped with oxygen masks and visors. Three manikin tests were performed at each impact level of 8, 10, 15, and 20 G with the 113-B helmet, and two tests were performed at each of these levels with the 116 helmet. The test matrix is listed below in Table 1.

TABLE 1. TEST MATRIX

TEST NO.	TEST CELL	HELMET	G-LEVEL
2330	A	113-B	8
2331	A	113-B	8
2332	A	113-B	8
2333	B	113-B	10
2334*	B	113-B	10
2335	B	113-B	10
2336	C	113-B	15
2337	C	113-B	15
2338	C	113-B	15
2339	D	113-B	20
2340	D	113-B	20
2341	D	113-B	20
2342	B	113-B	10
2343#	E	116	8
2344	E	116	8
2345	F	116	10
2346#	F	116	10
2347#	G	116	15
2348#	G	116	15
2349#	H	116	20
2350#	H	116	20

*Low Carriage Acceleration Input
#Y-Neck Data is Defective

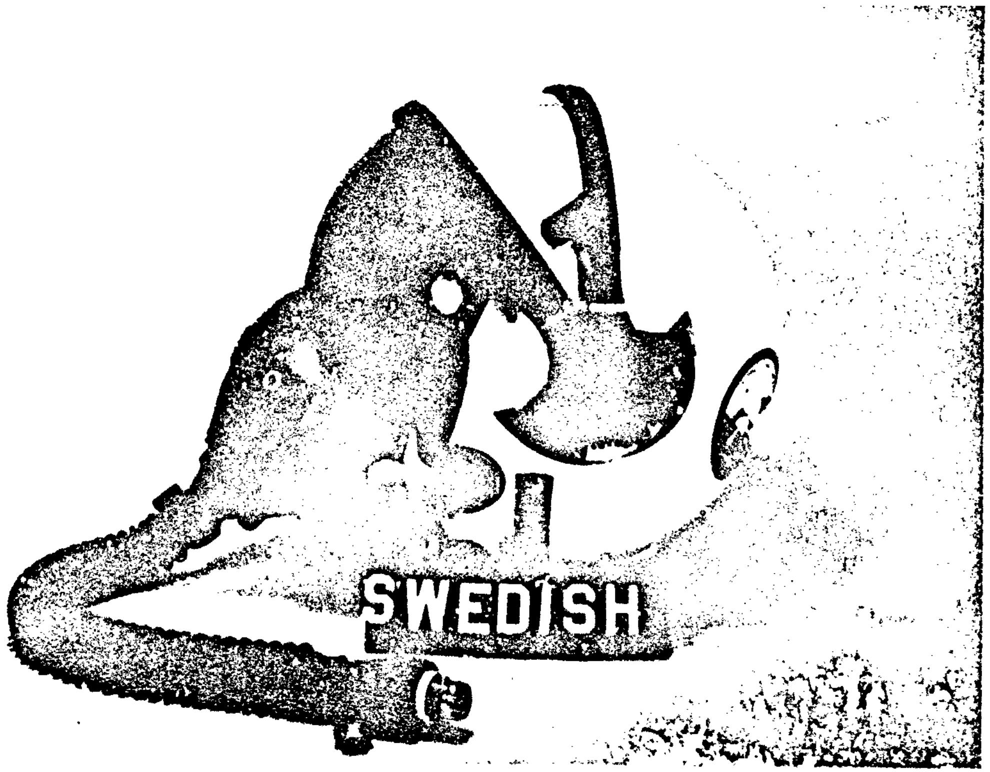

FIGURE 1. SWEDISH 113-B HELMET

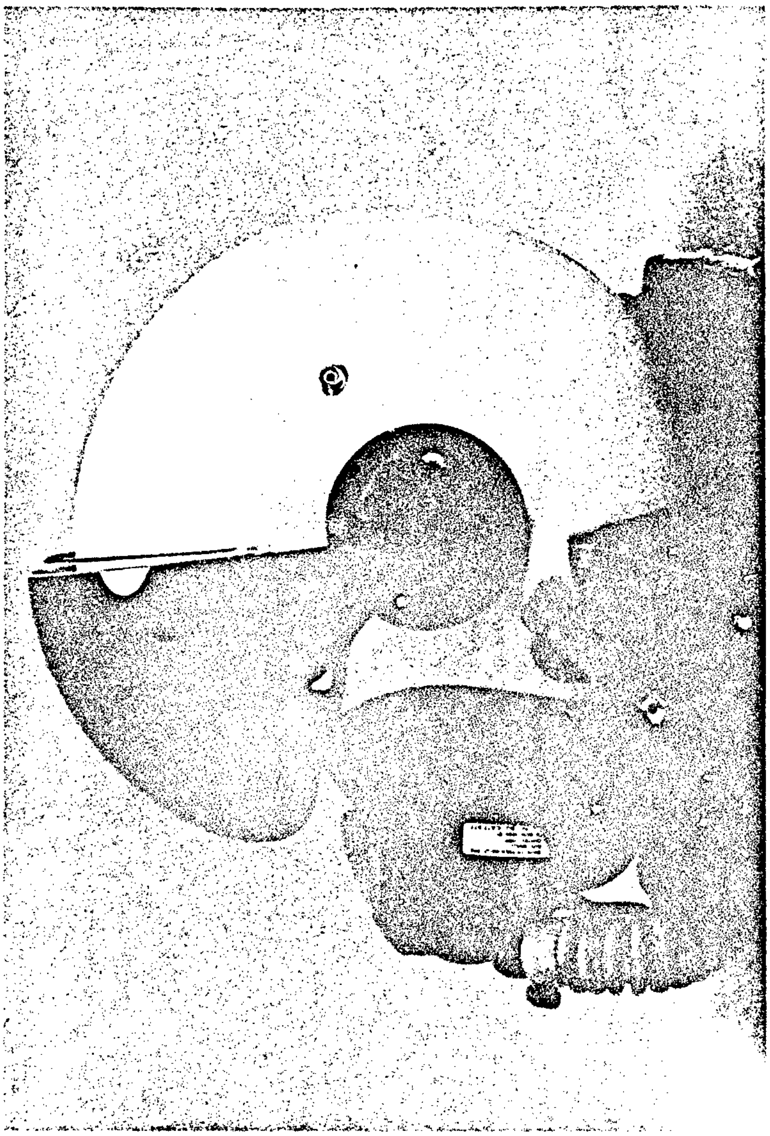

FIGURE 2. SWEDISH 116 HELMET

Mass Properties Measurements

Mass properties including weight, centers of gravity, and principal moments of inertia were measured for each helmet. The procedure involved placing each helmet in a support box, determining the centers of mass with a scale and moment table with the box at different positions, and then summing the moments for the x, y, and z axes while subtracting out the moments of the support fixture (4).

RESULTS

Structural Integrity

Neither the 113-B nor the 116 helmet sustained any structural damage in any of the impact tests, which ranged from 8 to 20 G. There was no damage to any part of the helmet system, including the oxygen mask and the visor.

Neck Loading

Data from the large ADAM impact tests showing the mean peak magnitudes of compression and shear forces on the neck for the two Swedish helmets are summarized in Table 2. (Individual test summary data are given in Appendix B). No torsional loading data are included in Table 2 since the ADAM manikin is a poor predictor of this force component. Data for USAF HGU-26/P and HGU-55/P helmets are also included for comparison and are shown in Table 3. Regression plots for compression force (+z axis) as a function of seat acceleration level are shown in Figure 3. As expected, the compression forces increased linearly with increasing acceleration level for all helmets ($r > 0.99$ for all four plots). Also as expected, the heavy Swedish 113-B helmet (5.53 lbs) generated larger forces than the lighter Swedish 116 helmet (3.55 lbs) at all acceleration input levels. Similarly, the heavier USAF HGU-26/P helmet (3.92 lbs) generated larger forces than the USAF HGU-55/P helmet (3.55 lbs). In comparing the Swedish and USAF helmets, however, the compression forces generated by the HGU-26/P helmet at 10 G and 15 G were slightly larger than those of the 113-E, although the 113-B is 1.6 lbs heavier. Also, the forces generated by the HGU-55/P were substantially larger than those of the 116, although both helmets were identical in weight.

TABLE 2. MEAN PEAK NECK FORCES FOR SWEDISH HELMETS

SEAT ACCEL (G)	HELMET	COMPRESSION FORCE (LBS)	SHEAR FORCE (LBS)
8	113-B	159.2	-36.1
10	113-B	209.2	-51.7
15	113-B	367.7	-74.8
20	113-B	577.9	-84.1
8	116	137.7	-37.8
10	116	185.6	-52.4
15	116	315.5	-79.0
20	116	504.9	-91.8

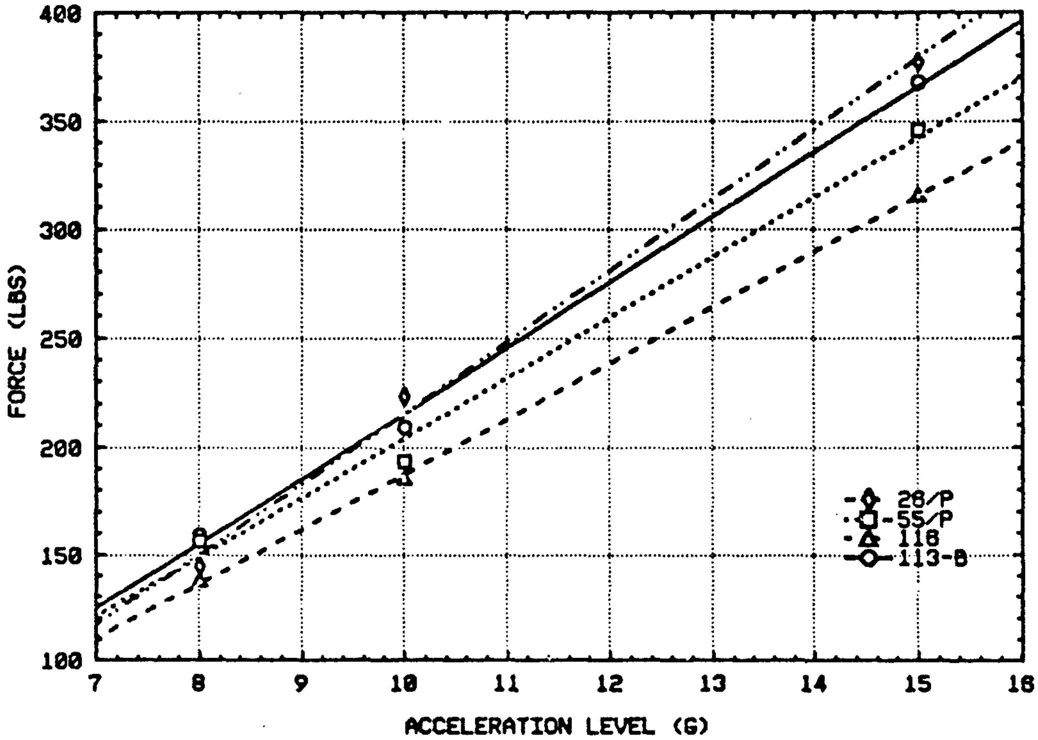

FIGURE 3. COMPRESSIVE NECK LOADING VS ACCELERATION LEVEL

TABLE 3. MEAN PEAK NECK FORCES FOR USAF HELMETS

SEAT ACCEL (G)	HELMET	COMPRESSION FORCE (LBS)	SHEAR FORCE (LBS)
8	HGU-55/P	156.3	-24.7
10	HGU-55/P	193.2	-64.9
15	HGU-55/P	345.6	-72.1
20	HGU-55/P	618.0	-106.9
8	HGU-26/P	144.5	-48.4
10	HGU-26/P	223.1	-62.1
15	HGU-26/P	377.2	-98.6
20	HGU-26/P	635.9	-98.1

Neck peak shear force (-x axis) for all helmets increased with increasing seat acceleration as seen in Figure 4. All increases in force were linear ($r > 0.99$) with the exception of the HGU-55/P helmet ($r = 0.81$). The plots for the two Swedish helmets show a close fit, with the heavier 113-B helmet (5.53 lbs) generating slightly less force than the 116 helmet (3.55 lbs). Shear forces for the USAF HGU-26/P helmet (3.92 lbs), however, were much larger than for the other three, as seen in the regression plots.

Helmet Mass Properties

Weights and centers of gravity (CG) were measured for both Swedish helmets (116 and 113-B) as shown in Table 4. All measurements are with respect to the ADAM (modified hybrid II headform) anatomical coordinate system as shown in Figure 5. ADAM headform properties are also shown in Table 4. The x-axis CG measurements for the 116 and 113-B helmets are 0.68" and 0.24" respectively, with the combined ADAM/helmet x-axis CG measurements shifted aft of the helmet alone measurements. The z-axis CG measurements for the 116 and 113-B helmets are 0.56" and 0.67" respectively. The combined ADAM/helmet z-axis CG measurements shifted upward from the helmet along measurements. The y-axis CG measurement for the 116 helmet was 0.03", while the 113-B helmet measured -0.24", demonstrating a lack of symmetry. Both combined ADAM/helmet y-axis CG measurements are shifted close to 0.0".

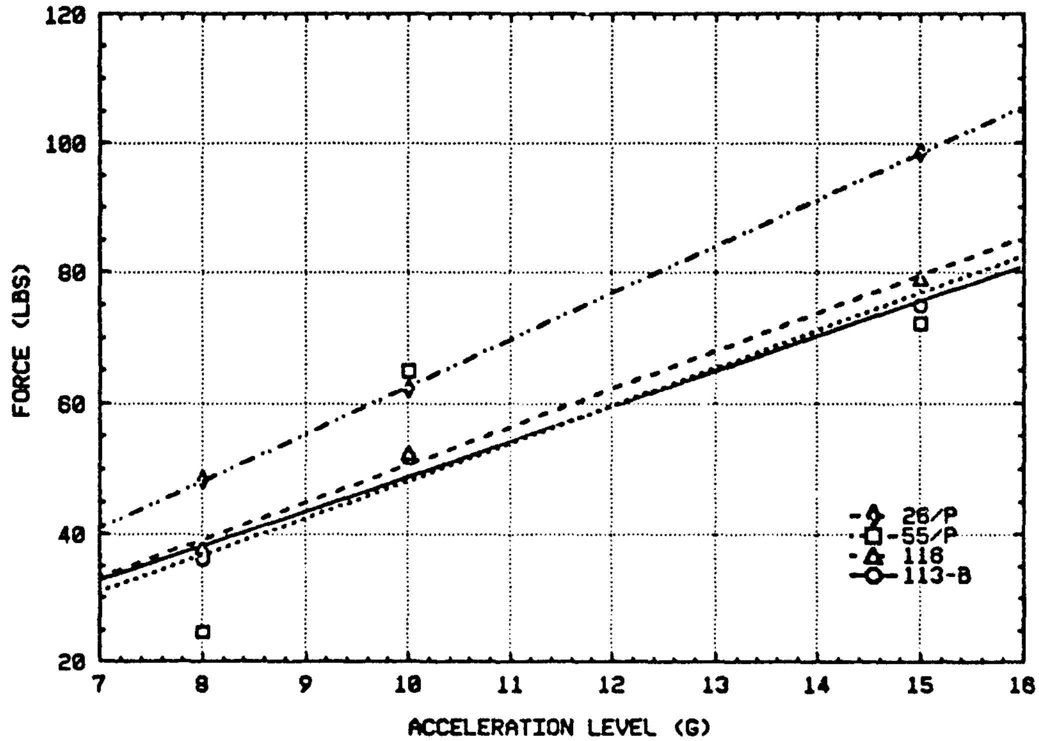

FIGURE 4. SHEAR NECK LOADING VS ACCELERATION LEVEL

TABLE 4. HELMET MASS PROPERTIES IN ADAM ANATOMICAL COORDINATES WITH AND WITHOUT ADAM HEAD

HELMET/ SUBJECT	WEIGHT (LBS)	X-AXIS (IN)	Y-AXIS (IN)	Z-AXIS (IN)
ADAM head	9.13	-0.30	-0.01	1.02
116	3.55	0.68	0.03	0.56
113-B	5.53	0.24	-0.24	0.67
*116/ADAM head	12.65	-0.03	0.00	0.90
113-B/ADAM Head	14.66	-0.26	-0.07	0.74

*Calculated from measurement helmet CG data above

The head anatomical coordinate axes system is defined as:

Y axis - vector from right tragion to left tragion
X axis - normal from Y axis to right infraorbitale
Z axis - X x Y
Origin - intersection of Y axis and a normal passing through sellion

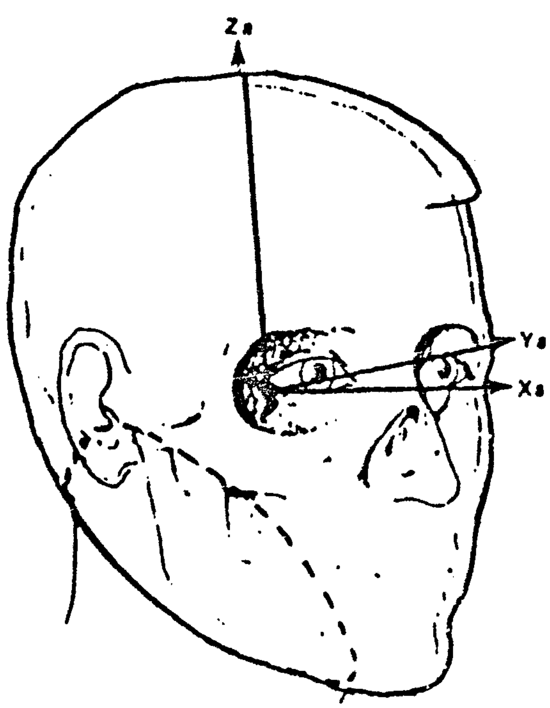

FIGURE 3. HEAD ANATOMICAL COORDINATE AXES SYSTEM

DISCUSSION

All four helmets generated the expected linear increases in neck peak compression loading with increasing +Gz seat acceleration. Also as expected, the heavier Swedish helmet generated larger compression forces than the lighter Swedish helmet due to its greater mass. The same was true in comparisons between the two USAF helmets. The Swedish helmets, however, generated smaller compression forces than expected in comparison with the USAF helmets. Variations in the centers of gravity among the helmets could have contributed to these results. Another factor could have been the helmet fit, since the two Swedish helmets had an extremely tight fit on the ADAM manikin head, while the USAF helmets were both snug but not as tight.

All helmets also demonstrated increases in neck peak shear loading (-x) with increasing acceleration, although the HGU-55/P helmet data were unexpectedly non-linear. Variations in helmet weight did not demonstrate a significant effect on neck shear loading, since the heavier Swedish 113-B helmet actually generated slightly lower shear force than the lighter Swedish 116 helmet, and the HGU-26/P generated larger neck forces than the other three helmets, whose regression plots were clustered together. Variations in the helmet centers of mass and helmet fit could have again contributed to these results.

CONCLUSIONS

The heavier 113-B Swedish helmet generated larger compression forces than the lighter 116 Swedish helmet due to its greater mass. However, when compared to the USAF helmets, the Swedish helmets generated substantially less compression loading than expected. In terms of peak shear loading, the HGU-26/P helmet generated larger magnitudes than the other three helmets. Unlike the compression loading, however, variations in weight did not appear to have a significant effect on shear loading. Contributing factors in both compression and shear force variations among the helmets appeared to be differences in the helmet centers of mass and/or helmet fit. Further studies are recommended to quantify these variables since significant reductions in pilot head/neck loading could conceivably be achieved without corresponding reductions in helmet weight.

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APPENDIX A

TEST CONFIGURATION AND

DATA ACQUISITION SYSTEM FOR THE

EVALUATION OF THE EFFECTS OF SWEDISH

FLIGHT HELMETS ON HUMAN RESPONSE

DURING +Gz IMPACT ACCELERATIONS

(SWEDISH HELMET STUDY)

TEST PROGRAM

Prepared under
Contract F33615-91-C-0531

February 1992

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INTRODUCTION

This report was prepared by DynCorp for the Armstrong Laboratory (AL/CFBE) under Air Force Contract F33615-91-C-0531.

The information provided herein describes the test facility, seat fixture, restraint configuration, test subjects, data acquisition, and the instrumentation procedures that were used in The Evaluation of the Effects of Swedish Flight Helmets on Human Response During +Gz Impact Accelerations (Swedish Helmet Study) Test Program. Twenty-one tests were conducted from 24 September 1991 through 26 September 1991 on the Vertical Deceleration Tower Test Facility.

These tests were performed during the Evaluation of the Effects of Variable Head-Mounted Weight on Human Response During +Gz Impact Accelerations (VWI Study) Test Program. Therefore, the tests were performed using the specifications as required in the Test Plan for the VWI Study.

1. TEST FACILITY

The AL/CFBE Vertical Deceleration Tower, as shown in Figure A-1, was used for all of the tests.

The facility consists of a 60 foot vertical steel tower which supports a guide rail system, an impact carriage supporting a plunger, a hydraulic deceleration device and a test control and safety system. The impact carriage can be raised to a maximum height of 42 feet prior to release. After release, the carriage free falls until the plunger, attached to the undercarriage, enters a water filled cylinder mounted at the base of the tower. The deceleration profile produced as the plunger displaces the water in the cylinder is determined by the free fall distance, the carriage and test specimen mass, the shape of the plunger and the size of the cylinder orifice. A rubber bumper is used to absorb the final impact as the carriage stops. For these tests, plunger number 102 was mounted under the carriage. Drop height varied depending on the test cell requirements which ranged from 8'6" to 26'0".

2. SEAT FIXTURE

The VIP seat fixture, as shown in Figure A-2, was used for all of the tests. The seat was designed to withstand vertical impact accelerations up to 50 G. The adjustable seat back was not adjusted during this study as all of the tests were run at the 0 degree seat back angle. The headrest was in line with the seat back. When positioned in the seat, the subject's upper legs were bent 90 degrees outward to a horizontal position with his lower legs bent 90 degrees downward to a vertical position. The subject was secured in the seat with a conventional two-strap shoulder harness and lap belt. The lap belt and shoulder strap were preloaded to 20 ±5 pounds as required in the test plan.

Each of the subject's legs were restrained by a strap that encircled the subject's calf and was attached to the carriage. Another strap crossed the subject's thighs and attached to the seat pan posterior to the knees. The subject's hands were placed under the thigh restraint. These restraints are illustrated by Figure A-3.

3. TEST SUBJECTS

One Advanced Dynamic Anthropomorphic Manikin (ADAM) representative of the "large" flying population was used during this test program.

4. TEST CONFIGURATIONS

The Swedish heavy 113-B helmet and light 116 helmet were used during this test program. Figure A-4 illustrates the heavy 113-B helmet and Figure A-5 illustrates the light 116 helmet.

5. INSTRUMENTATION

The electronic data collected during this test program is described in Sections 5.1 and 5.2. Section 5.1 discusses accelerometers while Section 5.2 discusses load transducers. Section 5.3 discusses the calibration procedures that were used. The measurement instrumentation used in this test program is listed in Tables A-1a through A-1c. These figures designate the manufacturer, type, serial number, sensitivity and other pertinent data on each transducer used. Table A-2 lists the manufacturer's typical transducer specifications.

Accelerometers and load transducers were chosen to provide the optimum resolution over the expected test load range. Full scale data ranges were chosen to provide the expected full scale range plus 50% to assure the capture of peak signals. All transducer bridges were balanced for optium output prior to the start of the program. The accelerometers were adjusted for the effect of gravity using computer processing software. The component of a 1 G vector in line with the force of gravity that lies along the accelerometer axis was added to each accelerometer.

The accelerometer and load transducer coordinate systems are shown in Figure A-6. The seat coordinate system is right-handed with the z axis parallel to the seat back and positive upward. The x axis is perpendicular to the z axis and positive eyes forward from the subject. The y axis is perpendicular to the x and z axes according to the right hand rule. The origin of the seat coordinate system is designated as the seat reference point (SRP). The SRP is at the midpoint of the line segment formed by the intersection of the seat pan and seat back. All vector components (for accelerations, angular accelerations, forces, moments, etc.) were positive when the vector component (x, y and z) was in the direction of the positive axis.

The linear accelerometers were wired to provide a positive output voltage when the acceleration experienced by the accelerometer was applied in the +x, +y and +z directions, as shown in Figure A-6.

The angular Ry accelerometers were wired to provide a positive output voltage when the angular acceleration experienced by the angular accelerometer was applied in the +y direction according to the right hand rule, as shown in Figure A-6.

The load cells and load links were wired to provide a positive output voltage when the force exerted by the load cell on the subject was applied in the +x, +y or +z direction as shown in Figure A-6.

All transducers except the carriage accelerometers and the carriage velocity tachometer were referenced to the seat coordinate system. The carriage tachometer was wired to provide a positive output voltage during freefall. The carriage accelerometers were referenced to the carriage coordinate system, as shown in Figure A-6.

The ADAM manikin internal transducers were referenced to the manikin coordinate system which is shown in Figure A-7.

The manikin neck load cell was wired to provide a positive output voltage when the force exerted by the load cell, on the neck, was applied in the +x, +y or +z directions as shown in Figure A-7.

The manikin My torque transducer was wired to provide a positive output voltage when the torque experienced by the transducer was applied in the +y direction according to the right hand rule, as shown in Figure A-7.

Carriage velocity was measured using a Globe Industries tachometer Model 22A672-2. The rotor of the tachometer was attached to an aluminum wheel with a rubber "O" ring around its circumference to assure good rail contact. The wheel contacted the track rail and rotated as the carriage moved, producing an output voltage proportional to the velocity.

5.1 Accelerometers

This section describes the accelerometer instrumentation as required in the AL/CFBE test plan.

The chest accelerometer package consisted of three Endevco Model 7264-200 linear accelerometers mounted to a 1/2 x 1/2 x 1/2 inch aluminum block. An Endevco Model 7302A angular (Ry) accelerometer was mounted on a bracket adjacent to the triaxial chest block. The accelerometer packages were inserted into a steel protection shield to which a length of Velcro fastener strap was attached. The package was placed over the manikin's sternum at the level of the xiphoid and was held there by fastening the Velcro strap around the manikin's chest. A chest fiducial target was attached directly on top of the chest accelerometer package. Figure A-8 illustrates the chest accelerometer package.

Carriage accelerations were measured using three Endevco linear accelerometers: one model 2262A-200 for acceleration in the z direction and two models 2264-200 for accelerations in the x and y directions. The three accelerometers were mounted on a small acrylic block and located behind the seat on the VIP seat structure.

Seat accelerations were measured using three Endevco linear accelerometers: two Models 2264-150 for accelerations in the x and z directions and one model 2264-200 for acceleration in the y direction. The three linear accelerometers were attached to a 1 x 1 x 3/4 inch acrylic block and were mounted near the center of the load cell mounting plate.

Head accelerations for manikin tests were measured using three Endevco Model 2264-200 linear accelerometers and one Endevco Model 7302B angular (Ry) accelerometer. These accelerometers were internally mounted in the head of the manikin.

5.2 Load Transducers

This section describes the load transducer instrumentation as required in the AL/CFBE test plan.

The load transducer locations and dimensions are shown in Figures A-9a and A-9b.

Shoulder/anchor forces were measured using one GM/DYN 3D-SW and two AAMRL/DYN 3D-SW triaxial load cells, each capable of measuring forces in the x, y and z directions. The parameters measured are indicated below:

Shoulder x, y and z force
Left lap belt x, y and z force
Right lap belt x, y and z force

The lap/vertical anchor force triaxial load cells were located on separate brackets mounted on the side of the seat frame parallel to the seat pan.

The shoulder strap force triaxial load cell was mounted on the seat frame between the seat back support plate and the headrest.

Left, right and center seat forces were measured using three load cells and three load links. The three load cells included three Strainsert Model FL2.5U-2SPKT load cells. The three load links, as shown in Figure A-10, were fabricated by DynCorp using Micro Measurement Model EA-06-062TJ-350 strain gages. All six measurement devices were located under the seat pan support plate. The load links were used for measuring loads in the x and y directions, two in the x direction and one in the y direction. Each load link housed a swivel ball which acted as a coupler between the seat pan and load cell mounting plate. The Strainsert load cells were used for measuring loads in the z direction. The seat pan instrumentation and the lap belt anchor load cells can be seen in Figure A-11.

Upper and lower headrest x forces were each measured using two Strainsert Model FL1U-2SG load cells. The load cells were mounted on a rectangular mounting plate which was attached to the upper seat back. The headrest was attached directly to the load cells. The headrest was adjusted up or down depending on the location of the subject's head. The headrest and shoulder belt anchor load cells can be seen in Figure A-12.

For large ADAM manikin tests, Neck x, y and z forces and My torque were measured using a Denton Model 1716 load cell. This load cell was internally mounted in the manikin.

5.3 Calibration

Calibrations are normally performed before and after testing to confirm the accuracy and functional characteristics of the transducers. Pre-program calibrations for the Swedish Helmet Study are the pre-program calibrations that were performed for the "Evaluation of the Effects of Variable Head-Mounted Weight on Human Response During +Gz Impact Acceleration (VWI Study) test program." Pre-program calibrations are given in Tables A-3a through A-3d. Post-program calibrations will be performed after the completion of the VWI Study testing.

The calibration of all Strainsert load cells was performed by the Precision Measurement Equipment Laboratories (PMEL) at Wright-Patterson Air Force Base. PMEL calibrated these devices on a periodic basis and provided current sensitivity and linearity data.

The calibration of the accelerometers was performed by DynCorp using the comparison method (Ensor, 1970). A laboratory standard accelerometer, calibrated on a yearly basis by Endevco with standards traceable to the National Bureau of Standards, and a test accelerometer were mounted on a shaker table. The frequency response and phase shift of the test accelerometer were determined by driving the shaker table with a random noise generator and analyzing the outputs of the accelerometers with a Zenith 248/12 computer using Fourier analysis. The natural frequency and the damping factor of the test accelerometer were determined, recorded and compared to previous calibration data for that test accelerometer. Sensitivities were calculated at 40 G and 100 Hertz. The sensitivity of the test accelerometer was determined by comparing its output to the output of the standard accelerometer.

The angular accelerometers were calibrated by DynCorp by comparing their output to the output of a linear standard accelerometer. The angular accelerometer is mounted parallel to the axis of rotation of a Honeywell low inertia D. C. motor. The standard accelerometer is mounted perpendicular to the axis of rotation at a radius of one inch to measure the tangential acceleration. The D. C. motor motion is driven at a constant sinusoidal angular acceleration of 100 Hertz and the sensitivity is calculated by comparing the rms output voltages of the angular and linear accelerometers.

The shoulder/lap triaxial load cells and load links were calibrated by DynCorp. These transducers were calibrated to a laboratory standard load

cell in a special test fixture. The sensitivity and linearity of each test load cell were obtained by comparing the output of the test load cell to the output of the laboratory standard under identical loading conditions. The laboratory standard load cell, in turn, is calibrated by PMEL on a periodic basis.

The velocity wheel is calibrated periodically by DynCorp by rotating the wheel at approximately 2000, 4000 and 6000 revolutions per minute (RPM) and recording both the output voltage and the RPM.

6. DATA ACQUISITION

Data acquisition was controlled by a comparator on the Master Instrumentation Control Unit in the Instrumentation Station. The test was initiated when the comparator countdown clock reached zero. The comparator was set to start data collection at a preselected time.

A reference mark pulse was generated to mark the ADACS electronic data and Selspot optical motion data at a preselected time after test initiation to place the reference mark close to the impact point. The reference mark time was used as the start time for data processing of the electronic and Selspot optical motion data.

Prior to each test and prior to placing the subject in the seat, data were recorded to establish a zero reference for all data transducers. These data were stored separately from the test data and were used in the processing of data.

6.1 Automatic Data Acquisition and Control System (ADACS)

Installation of the ADACS instrumentation is shown in Figure A-13. The three major components of the ADACS system are the power conditioner, signal conditioners and the encoder. A block diagram of the ADACS is shown in Figure A-14. The signal conditioners contain forty-eight amplifiers with programmable gain and filtering.

Bridge excitation for load cells and accelerometers was 10 VDC. Bridge completion and balance resistors were added as required to each module input connector.

The forty-eight module output data signals were digitized and encoded into forty-eight 11-bit digital words. Two additional 11-bit synchronization (sync) words were added to the data frame making a fifty word capability.

Three synchronization pulse trains (bit sync, word sync and frame sync) were added to the data frame and sent to the computer via a junction box data cable.

The PDP 11/34 minicomputer received serial data from the ADACS. The serial data coming from the carriage are converted to parallel data in the data formatter. The data formatter inputs data by direct memory access (DMA)

into the PDP 11/34 computer memory via a buffered data channel where data are temporarily stored on disk. Data are later transferred to the VAX 11/750 and output to magnetic tape for permanent storage. The interrelationships among the data acquisition and storage equipment are shown in Figure A-15.

Test data could be reviewed immediately after each test by using the "quick look" SCAN routine. SCAN was used to produce a plot of the data stored on any channel as a function of time. The routine determined the minimum and maximum values of any data plot. It was also used to calculate the rise time, pulse duration and carriage acceleration and create a disk file containing significant test parameters.

6.2 Selspot Motion Analysis System

The Selspot Motion Analysis System utilizes photosensitive cameras to track the motion of infrared LED targets attached to different points on the test fixture. The three-dimensional motion of the LEDs was determined by combining the images from two different Selspot cameras. The two Selspot cameras were mounted onboard the carriage. The side camera was a Selspot Model 411-2 (S/N 385) and the oblique camera was a Selspot Model 411-2 (S/N 384). Both cameras had 24 mm lenses. The Selspot cameras are shown in Figure A-16.

The Selspot System includes a GraphOn GO-230 terminal and a Motorola 68030 VME based microcomputer with 8 Mbyte RAM, a camera interface module (MCIM), a 1.2 Mbyte floppy disk and a 120 Mbyte hard disk. The microcomputer uses the Motorola VERSADOS operating system. The Selspot data collection and processing are performed by the Selspot MULTILAB System software.

The Selspot System was calibrated by determining the camera locations and orientations prior to the start of the test program. The camera locations and orientations were referenced to the coordinate system of the Position Reference Structure (PRS). The PRS is shaped as a tetrahedron with reference LEDs 1, 2, 3 and 4 located at the vertices. The PRS is shown in Figure A-17.

Motion of the subjects' helmet, mouth, neck, shoulder and chest were quantified by tracking the motion of subject-mounted LEDs. Four reference LEDs were placed on the test fixture. The locations of the LEDs generally followed the guidelines provided in "Film Analysis Guides for Dynamic Studies of Test Subjects, Recommended Practice (SAE J138, March 1980)." Figures A-18 and A-19 identify the LED target locations.

Photogrammetric data was collected from the six moving and four reference LEDs at a 500 Hz sample rate during the impact. Data collection started at T = -3 seconds for 5 seconds. The photogrammetric data was copied to a magnetic tape for permanent storage.

The data was processed starting at the reference mark time for 600 milliseconds on the Selspot Motion Analysis System, shown in the block diagram in Figure A-20. The camera image coordinates were corrected for

camera vibration, converted into three-dimensional coordinates, and transformed into the seat coordinate seat.

A Kodak Ektapro 1000 video system was also used to provide onboard coverage of each test. This video recorder and display unit is capable of recording high-speed motion up to a rate of 1000 frames per second. Immediate replay of the impact is possible in real time or in slow motion.

7. PROCESSING PROGRAMS

The executable images for the ADACS processing programs are located in directory PROCESS of the VAX 11/750 and the test data is assumed to be stored in logical directory DATADIR. All plots and the test summary sheet are output to the LN03 laser printer. The test base file is output to directory PROCESS.

The two Fortran programs that process the ADACS test data for the SHS Study (Vertical Deceleration Tower facility) are named SHSVDTOA and SHSVDTOB. The DCL file which controls the execution of these programs is named SHSVDT. The character string 'SHS' identifies the study, 'VDT' identifies the facility (Vertical Deceleration Tower), '0' is the revision number and the last character determines the program order of execution.

SHSVDTOA accepts user input and creates a temporary DCL file which controls the sequential batch processing of a specified number of tests. SHSVDTOA requests the user to enter the total number of tests to be processed and the test number of each test. Logical directory DATADIR is assumed to contain a zero reference file named '<test no>Z.VDT', a test data file named '<test no>D.VDT' and a sensitivity file named '<test no>S.VDT'.

SHSVDTOA requests the user to enter the total number of tests to be processed and the test number for each test. The default test parameters are retrieved from the header block of the test data file and displayed as a menu on the screen. The user may specify new values for any of the displayed test parameters. The test parameters include the subject ID, weight, age, height and sitting height. Additional parameters include the cell type, nominal G level, subject type (manikin or human) and belt preload status (computed or not computed). If the belt preloads were computed, then the left lap, right lap and shoulder strap preloads are also displayed.

SHSVDTOB generates time histories for the carriage and seat x, y and z axis linear accelerations, and the carriage velocity. Time histories for the head and chest linear and angular accelerations, and the resultant linear accelerations are computed. Other quantities include the shoulder x, y and z axis forces; the left and right lap x, y and z axis forces; the headrest forces; and the x, y and z axis seat forces.

Resultants are computed for the shoulder, left lap, right lap and seat. The seat Z force is corrected to subtract out the force due to the mass of the seat pan. The dynamic response of the DRI model is computed for the seat

z axis acceleration. The ADAM neck x, y, z, and resultant forces, and the ADAM neck My torque are computed if the ADAM manikin is used.

The impact rise time, duration and velocity change are computed and stored in the test base file. Values for the preimpact level and the extrema for each time history are stored in the test base file and printed out as a summary sheet for each test. The time histories are also plotted.

DIGITAL INSTRUMENTATION REQUIREMENTS

DYNCORP

PROGRAM SWEDISH HELMET STUDY **DATE** 24 SEP 91 **THRU** 26 SEP 91

FACILITY VERTICAL DECELERATION TOWER **RUN** 2330 **THRU** 2350

DATA CHANNEL	DATA POINT	XDUCER MFG & TYPE	SERIAL NUMBER	XDUCER SENS	EXCITE V	CHAN	FILTER SERIES	FILTER A/D	AMP GAIN	AMP A/D	SAMPLE RATE	SAMPLE FORMAT	FULL SCALE SENS.	FILTER HZ	XDUCER ZERO	RANGE	BRIDGE BALANCE RESISTORS	BRIDGE COMP RESISTORS	SPECIAL NOTATIONS
1	CARRIAGE x ACCEL.	ENDEVCO 2262A-200	FR31	5.0369 mv/G	10.00	1	60	1	10	1	1K	1	46.6G	120	2.5	±5.0 0.0	108K +IN GND.	-	
2	CARRIAGE x ACCEL.	ENDEVCO 2264-200	BP10	2.482 mv/G	10.00	2	60	2	50	11	1K	1	20.14G	120	2.5	±5.0 0.0	110K -IN VE	1.5K	
3	CARRIAGE y ACCEL.	ENDEVCO 2264-200	BN61	2.8969 mv/G	10.00	3	60	3	50	8	1K	1	17.26G	120	2.5	±5.0 0.0	172K +IN GND.	1.5K	
4	DUMMY HEAD x ACCEL.	ENDEVCO 2264-200	CH74	2.946 mv/G	10.00	4	60	4	25	36	1K	1	33.9G	120	2.5	±5.0 0.0	-	1.5K	
5	DUMMY HEAD y ACCEL.	ENDEVCO 2264-200	BQ42	2.7060 mv/G	10.00	5	60	5	25	24	1K	1	36.95G	120	2.5	±5.0 0.0	162K +IN GND.	1.5K	
6	DUMMY HEAD z ACCEL.	ENDEVCO 2264-200	CH73	2.7449 mv/G	10.00	6	60	6	10	5	1K	1	91.06G	120	2.5	±5.0 0.0	-	1.5K	
7	DUMMY HEAD Ry ANG ACCEL	ENDEVCO 7302B	TJ75	3.892 uv/RAD/SEC2	10.00	7	60	7	100	14	1K	1	6423 RAD/SEC2	120	2.5	±5.0 0.0	-	-	
8	CHEST x ACCEL.	ENDEVCO 7264-200	BH76H	3.1903 mv/G	10.00	8	60	8	10	10	1K	1	78.36G *	120	2.5	±5.0 0.0	76K +IN GND.	1.5K	TESTS 2330 THRU 2339 USEL A GAIN OF 25 (#1) FOR A FULL SCALE OF 31.35G
9	CHEST y ACCEL.	ENDEVCO 7264-200	BH81M	3.2628 mv/G	10.00	9	60	9	50	5	1K	1	15.36G	120	2.5	±5.0 0.0	-	1.5K	
10	CHEST z ACCEL.	ENDEVCO 7264-200	BH87M	2.9853 mv/G	10.00	10	60	10	10	24	1K	1	83.71G	120	2.5	±5.0 0.0	100K +IN GND.	1.5K	
11	CHEST Ry ANG ACCEL	ENDEVCO 7302A	AB15	6.763 uv/RAD/SEC2	10.00	11	60	11	100	27	1K	1	3696.5 RAD/SEC2	120	2.5	±5.0 0.0	-	-	
13	R. SEAT z FORCE	STRAINSERT FL2.5U-2 SPKT	7135-4	7.92 uv/LB	10.00	13	60	13	100	22	1K	1	3157 LB	120	2.5	±5.0 0.0	-	-	
14	C. SEAT z FORCE	STRAINSERT FL2.5U-2 SPKT	7135-1	7.97 uv/LB	10.00	14	60	14	50	10	1K	1	6274 LB	120	2.5	±5.0 0.0	-	-	

Computer: -6 to +3

All sensitivities were derived from pre-cals of VWI Study.
Channels 4-7 transducers utilize the human mouth pack of the VWI Study.

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TABLE A-1a: INSTRUMENTATION REQUIREMENTS

DIGITAL INSTRUMENTATION REQUIREMENTS

DYNCORP

PROGRAM SWEDISH HELMET STUDY DATE 24 SEP 91 THRU 26 SEP 91

FACILITY VERTICAL DECELERATION TOWER RUN 2330 THRU 2350

DATA CHANNEL	DATA POINT	XDUCER MFG & TYPE	SERIAL NUMBER	XDUCER SENS	EXCITE V	CHAN	FILTER SERIES	FILTER O/P	AMP GAIN	AMP O/P	SAMPLE RATE	SAMPLE FORMAT	FULL SCALE SENS.	FILTER HZ	XDUCER ZERO	RANGE	BRIDGE BALANCE RESISTORS	BRIDGE COMP RESISTORS	SPECIAL NOTATIONS
15	L. SEAT x FORCE	MM/DYN EA-06-0 62TJ-350	003	11.06 uv/LB	10.00	15	60	15	201	13	1K	1	1125 LB	120	2.5	+5.0 0.0	-	-	
16	R. SEAT x FORCE	MM/DYN EA-06-0 62TJ-350	3	10.80 uv/LB	10.00	16	60	16	201	5	1K	1	1152 LB	120	2.5	+5.0 0.0	-	-	
17	C. SEAT y FORCE	MM/DYN EA-06-0 62TJ-350	1	10.60 uv/LB	10.00	17	60	17	201	17	1K	1	1173 LB	120	2.5	+5.0 0.0	-	-	
18	L. LAP x LOAD	AAMRL/DYN 3D-SW	24X	7.2951 uv/LB	10.00	18	60	18	201	16	1K	1	1705 LB	120	2.5	+5.0 0.0	22K +IN GND.	-	
19	L. LAP y LOAD	AAMRL/DYN 3D-SW	24Y	6.8837 uv/LB	10.00	19	60	19	201	4	1K	1	1807 LB	120	2.5	+5.0 0.0	47K +IN GND.	-	
20	L. LAP z LOAD	AAMRL/DYN 3D-SW	24Z	7.8481 uv/LB	10.00	20	60	20	201	15	1K	1	1585 LB	120	2.5	+5.0 0.0	47K +IN GND.	-	
21	R. LAP x LOAD	AAMRL/DYN 3D-SW	15X	5.4860 uv/LB	10.00	21	60	21	201	8	1K	1	2267 LB	120	2.5	+5.0 0.0	13.9K +IN GND.	-	
22	R. LAP y LOAD	AAMRL/DYN 3D-SW	15Y	5.4133 uv/LB	10.00	22	60	22	402	8	1K	1	1149 LB	120	2.5	+5.0 0.0	17K +IN GND.	-	
23	R. LAP z LOAD	AAMRL/DYN 3D-SW	15Z	6.3499 uv/LB	10.00	23	60	24	201	3	1K	1	1959 LB	120	2.5	+5.0 0.0	3.9K -IN GND.	-	
24	VELOCITY	GLOBE 22A672-2	4	.0612 V/F/S	-	24	30	1	1	-	1K	1	81.7 F/S	60	2.5	+5.0 0.0	-	-	
25	SHOULDER x LOAD	GM/DYN 3D-SW	20Z	6.3058 uv/LB	10.00	25	60	25	402	6	1K	1	986 LB	120	2.5	+5.0 0.0	36K +IN GND.	-	
26	SHOULDER y LOAD	GM/DYN 3D-SW	20Y	5.2857 uv/LB	10.00	26	60	26	800	5	1K	1	591 LB	120	2.5	+5.0 0.0	33K +IN GND.	-	
27	SHOULDER z LOAD	GM/DYN 3D-SW	20X	4.8446 uv/LB	10.00	27	60	27	402	9	1K	1	1284 LB	120	2.5	+5.0 0.0	62K +IN GND.	-	
28	SEAT z ACCEL.	ENDEVCO 2264-150	BM39	3.1377 mv/G	10.00	28	60	28	50	2	1K	1	15.94G	120	2.5	+5.0 0.0	-	1.5K	

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TABLE A-1b: INSTRUMENTATION REQUIREMENTS

DIGITAL INSTRUMENTATION REQUIREMENTS

DYNCORP

PROGRAM SWEDISH HELMET STUDY DATE 24 SEP 91 THRU 26 SEP 91

FACILITY VERTICAL DECELERATION TOWER RUN 2330 THRU 2350

DATA CHANNEL	DATA POINT	XDUCER MFG & TYPE	SERIAL NUMBER	XDUCER SENS	EXCITE V	EXCITE CHAN	FILTER SERIES	FILTER S/H	AMP GAIN	AMP S/H	SAMPLE RATE	SAMPLE FORMAT	FULL SCALE SENS.	FILTER HZ	XDUCER ZERO	RANGE	BRIDGE BALANCE RESISTORS	BRIDGE COMP RESISTORS	SPECIAL NOTATIONS
29	SEAT y ACCEL.	ENDEVCO 2264-200	BX17	2.7509 mv/G	10.00	29	60	29	50	17	1K	1	18.18G	120	2.5	+5.0 0.0	91K +IN GND.	1.5K	
30	SEAT x ACCEL.	ENDEVCO 2264-15C	BB32	2.6389 mv/G	10.00	30	60	30	25	20	1K	1	37.89G	120	2.5	+5.0 0.0	-	1.5K	
31	L. ADAM NECK My	DENTON 1716	LC127-1	6.728 uv/LB	10.00	31	60	38	50	35	1K	1	7432 LB	[illegible]	2.5	+5.0 0.0	-	-	
32	UPPER HEAD REST x FORCE	STRAINSERT FL1U-2 SG	207	20.29 uv/LB	10.00	32	60	32	201	1	1K	1	613 LB	120	2.5	+5.0 0.0	-	-	
33	LOWER HEAD REST x FORCE	STRAINSERT FL1U-2 SG	218	20.00 uv/LB	10.00	33	60	33	201	12	1K	1	622 LB	120	2.5	+5.0 0.0	390K +IN GND.	-	
34	L. ADAM NECK x FORCE	DENTON 1716	LC127-1	8.221 uv/LB	10.00	34	60	34	100	37	1K	1	3040 LB	120	2.5	+5.0 0.0	-	-	
35	L. ADAM NECK y FORCE	DENTON 1716	LC127-1	8.100 uv/LB	10.00	35	60	35	201	6	1K	1	1536 LB	120	2.5	+5.0 0.0	-	-	
36	L. ADAM NECK z FORCE	DENTON 1716	LC127-1	4.631 uv/LB	10.00	36	60	36	201	9	1K	1	2686.8 LB	120	2.5	+5.0 0.0	-	-	
37	L. SEAT z FORCE	STRAINSERT FL2.5U-2 SPKT	7135-3	7.88 uv/LB	10.00	12	60	12	100	6	1K	1	3141 LB	120	2.5	+5.0 0.0	-	-	
45	EVENT	-	-	1.0 VOLT	-	45	1000	3	2.5	19	1K	1	2.5 VOLT	2000	5.0	+5.0 0.0	-	-	
46	T = 0	-	-	1.0 VOLT	-	46	1000	12	1	-	1K	1	5.0 VOLT	2000	5.0	+5.0 0.0	-	-	
47	BIAS VOLTAGE	-	-	1.0 VOLT	-	47	180	3	1	-	1K	1	2.5 VOLT	360	0.0	+5.0 0.0	-	-	
48	10 VOLT EXCITATION	-	-	1.0 VOLT	10.00	48	180	4	1	-	1K	1	2.5 VOLT	360	0.0	+5.0 0.0	-	-	

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TABLE A-1c: INSTRUMENTATION REQUIREMENTS

MANUFACTURER	MODEL	RANGE	SENSITIVITY (mv)	RESONANCE FREQ (Hz)	FREQUENCY RESPONSE (Hz.)	EXCITATION (Volt)	2 ARM or 4 ARM	ADDITIONAL NOTES
Endevco	2264-150	± 150 G	2.5/G	3400	0-800	10	2 arm	Linear accelerometer
Endevco	2264-200	± 200 G	2.5/G	4700	0-1200	10	2 arm	Linear accelerometer
Endevco	7264-200	± 200 G	2.5/G	6000	0-1200	10	2 arm	Linear accelerometer
Endevco	2262A-200	± 200 G	2.5/G	7000	0-2000	10	4 arm	Linear accelerometer
Endevco	7302A	± 50,000 Rad/Sec²	.0055 /Rad/Sec²	2500	1-600	10	4 arm	Angular accelerometer X10 overrange
Endevco	7302B	± 50,000 Rad/Sec²	.004 /Rad/Sec²	3000	1-600	10	4 arm	Angular accelerometer X10 overrange
Strainsert	FL2.5U-2SPKT	± 2500 LB	.008/LB	3600	0-2000	10	4 arm	Load cell 15 V max exc. 5 K LB max. overrange
Strainsert	FL1U-2SG	± 1000 LB	.020/LB	3600	0-2000	10	4 arm	Load cell 15 V max exc. 2 K LB max. overrange
Denton	1716	± 3000 LB	-	N/A	N/A	10	4 arm	6 axis load cell

TABLE A-2: TYPICAL TRANSDUCER SPECIFICATIONS

DYNCORP PROGRAM CALIBRATION LOG

PROGRAM SWEDISH HELMET STUDY **DATES:** 24 SEP 91 - 26 SEP 91

FACILITY VERTICAL DECELERATION TOWER **RUN NUMBERS:** 2330 - 2350

DATA POINT	TRANSDUCER MFG.& MODEL	SERIAL NUMBER	PRE-CAL		POST-CAL		%CHANGE	NOTES
			DATE	SENS	DATE	SENS		
CARRIAGE z ACCEL.	ENDEVCO 2262A-200	FR31	31 MAY 91	5.0369 mv/G				
CARRIAGE x ACCEL.	ENDEVCO 2264-200	BP10	27 MAR 90	2.482 mv/G				
CARRIAGE y ACCEL.	ENDEVCO 2264-200	BN61	31 MAY 91	2.8969 mv/G				
DUMMY HEAD x ACCEL.	ENDEVCO 2264-200	CH74	11 APR 91	2.946 mv/G				
DUMMY HEAD y ACCEL.	ENDEVCO 2264-200	BQ42	11 APR 91	2.7060 mv/G				
DUMMY HEAD z ACCEL.	ENDEVCO 2264-200	CH73	11 APR 91	2.7449 mv/G				
DUMMY HEAD ANG. Ry ACCEL.	ENDEVCO 7302B	TJ75	15 APR 91	3.892 uv/RAD/SEC2				
CHEST x ACCEL.	ENDEVCO 7264-200	BH76H	11 APR 91	3.1903 mv/G				
CHEST y ACCEL.	ENDEVCO 7264-200	BH81H	11 APR 91	3.2628 mv/G				
CHEST z ACCEL.	ENDEVCO 7264-200	BH87H	11 APR 91	2.9853 mv/G				

TABLE A-3a: TRANSDUCER PRE- AND POST-CALIBRATION PAGE 1 OF 4

DYNCORP PROGRAM CALIBRATION LOG

PROGRAM SWEDISH HELMET STUDY **DATES:** 24 SEP 91 - 26 SEP 91

FACILITY VERTICAL DECELERATION TOWER **RUN NUMBERS:** 2330 - 2350

DATA POINT	TRANSDUCER MFG.& MODEL	SERIAL NUMBER	PRE-CAL		POST-CAL		XCHANGE	NOTES
			DATE	SENS	DATE	SENS		
CHEST Ry ANG. ACCEL	ENDEVCO 7302A	AB15	15 APR 91	6.763 uv/RAD/ SEC2				
LEFT SEAT z FORCE	STRAINSERT FL2.5U-2SPKT	7135-3	16 NOV 90	7.88 uv/LB				CALIBRATED PERIODI- CALLY BY PMEL
RIGHT SEAT z FORCE	STRAINSERT FL2.5U-2SPKT	7135-4	13 FEB 91	7.92 uv/LB				CALIBRATED PERIODI- CALLY BY PMEL
CENTER SEAT z FORCE	STRAINSERT FL2.5U-2SPKT	7135-1	18 APR 91	7.97 uv/LB				CALIBRATED PERIODI- CALLY BY PMEL
LEFT SEAT x FORCE	MM/DYN EA-06-062TJ-350	003	17 APR 91	11.06 uv/LB				
RIGHT SEAT x FORCE	MM/DYN EA-06-062TJ-350	3	17 APR 91	10.80 uv/LB				
CENTER SEAT y FORCE	MM/DYN EA-06-062TJ-350	1	17 APR 91	10.60 uv/LB				
LEFT LAP x FORCE	AAMRL/DYN 3D-SW	24X	15 APR 91	7.2951 uv/LB				
LEFT LAP y FORCE	AAMRL/DYN 3D-SW	24Y	15 APR 91	6.8837 uv/LB				
LEFT LAP z FORCE	AAMRL/DYN 3D-SW	24Z	15 APR 91	7.8481 uv/LB				

TABLE A-3b: TRANSDUCER PRE- AND POST-CALIBRATION

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DYNCORP PROGRAM CALIBRATION LOG

PROGRAM SWEDISH HELMET STUDY DATES: 24 SEP 91 - 26 SEP 91

FACILITY VERTICAL DECELERATION TOWER RUN NUMBERS: 2330 - 2350

DATA POINT	TRANSDUCER MFG.& MODEL	SERIAL NUMBER	PRE-CAL		POST-CAL		XCHANGE	NOTES
			DATE	SENS	DATE	SENS		
RIGHT LAP x FORCE	AAMRL/DYN 3D-SW	15X	28NOV90	5.486 uv/LB				
RIGHT LAP y FORCE	AAMRL/DYN 3D-SW	15Y	28NOV90	5.4133 uv/LB				
RIGHT LAP z FORCE	AAMRL/DYN 3D-SW	15Z	28NOV90	6.3499 uv/LB				
VELOCITY	GLOBE 22A672-2	4	27JUL89	.0612 V/F/S	-	-	-	CALIBRATED PERIODICALLY
SHOULDER x	GM/DYN 3D-SW	20Z	15APR91	6.3058 uv/LB				
SHOULDER y	GM/DYN 3D-SW	20Y	15APR91	5.2857 uv/LB				
SHOULDER z	GM/DYN 3D-SW	20X	15APR91	4.8846 uv/LB				
SEAT x ACCEL.	ENDEVCO 2264-150	BN39	31MAY91	3.1377 mv/G				
SEAT y ACCEL.	ENDEVCO 2264-200	BX17	31MAY91	2.7509 mv/G				
SEAT z ACCEL.	ENDEVCO 2264-150	BB32	31MAY91	2.6389 mv/G				

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TABLE A-3c: TRANSDUCER PRE- AND POST-CALIBRATION

DYNCORP PROGRAM CALIBRATION LOG

PROGRAM SWEDISH HELMET STUDY **DATES:** 24 SEP 91 - 26 SEP 91

FACILITY VERTICAL DECELERATION TOWER **RUN NUMBERS:** 2330 - 2350

DATA POINT	TRANSDUCER MFG.& MODEL	SERIAL NUMBER	PRE-CAL		POST-CAL		%CHANGE	NOTES
			DATE	SENS	DATE	SENS		
LARGE ADAM NECK My TORQUE	DENTON 1716	LC127-1	07JUN91	6.728 uv/LB				ALL ADAM CALIBRATAIONS ON THIS PAGE ARE SRL'S RESPONSIBILITY.
LARGE ADAM NECK x FORCE	DENTON 1716	LC127-1	07JUN91	8.221 uv/LB				
LARGE ADAM NECK y FORCE	DENTON 1716	LC127-1	07JUN91	8.100 uv/LB				
LARGE ADAM NECK z FORCE	DENTON 1716	LC127-1	07JUN91	4.631 uv/LB				
UPPER HEADREST x FORCE	STRAINSERT FL1U-2SG	207	05JAN89	20.29 uv/LB				CALIBRATED PERIODICALLY BY PMEL
LOWER HEADREST x FORCE	STRAINSERT FL1U-2SG	218	31OCT91	20.00 uv/LB				CALIBRATED PERIODICALLY BY PMEL

TABLE A-3d: TRANSDUCER PRE- AND POST-CALIBRATION **PAGE 4 OF 4**

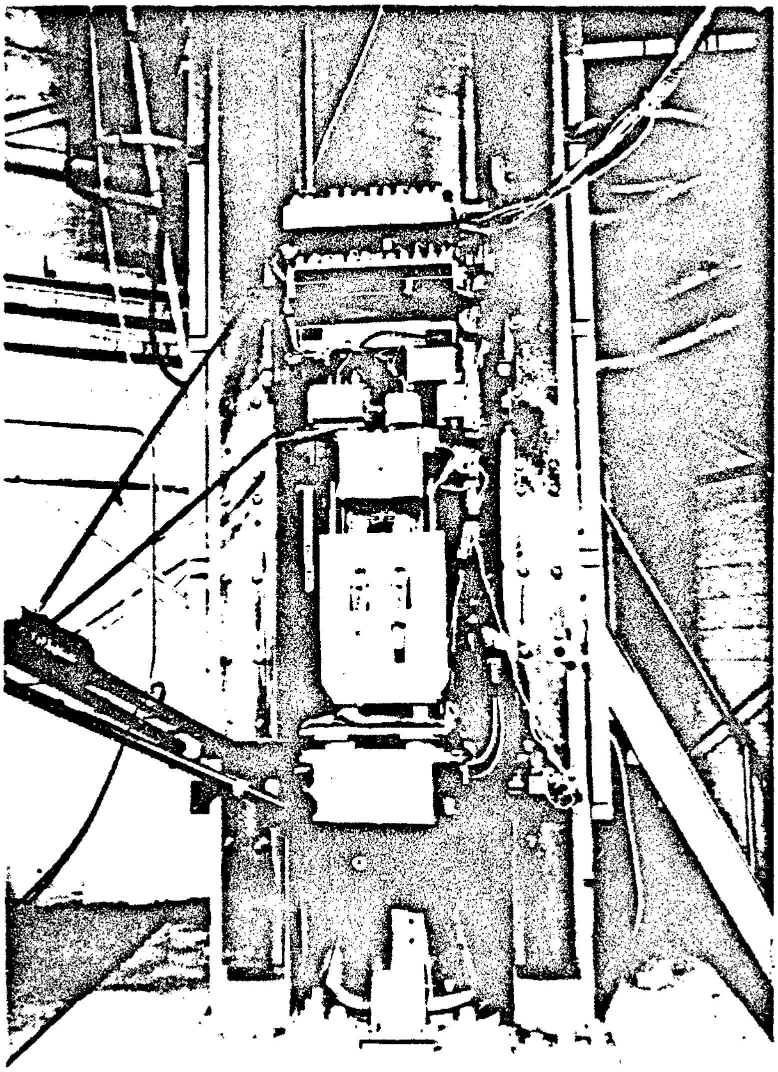


FIGURE A-1: AL/CFBE VERTICAL DECELERATION TOWER

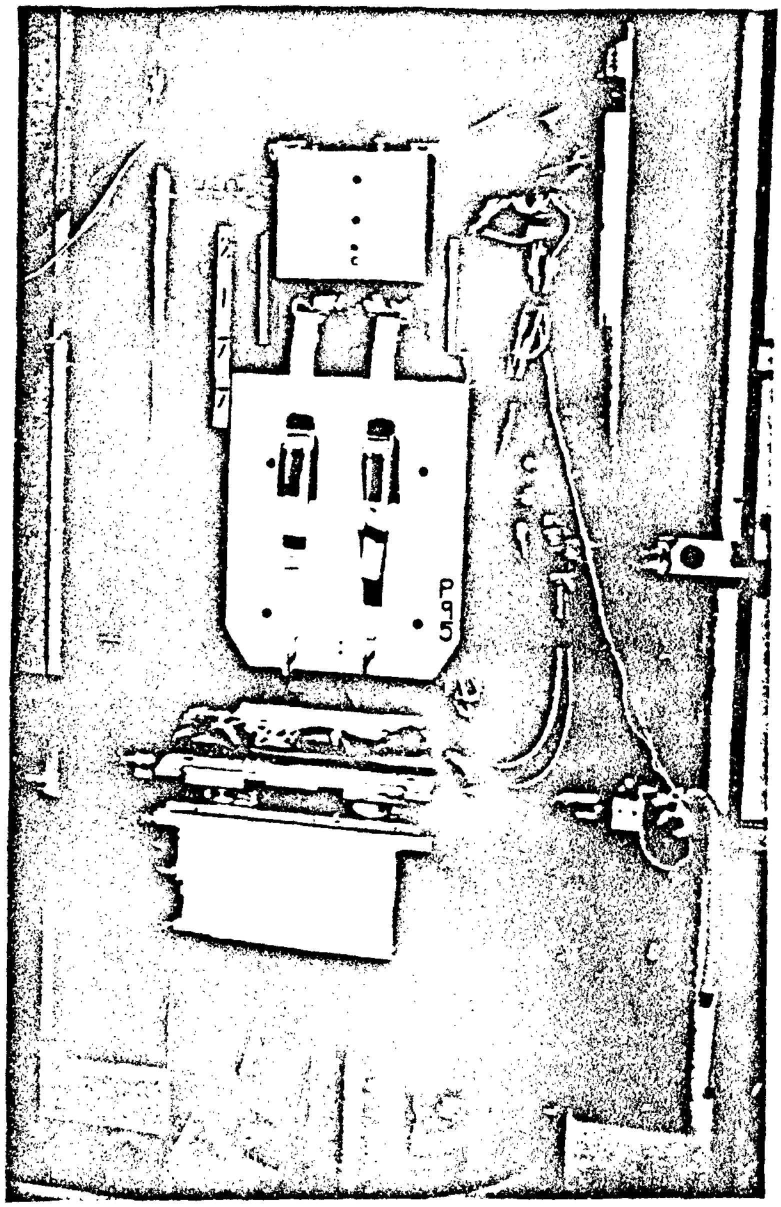


FIGURE A-2: VIP SEAT FIXTURE

FIGURE A-3: SUBJECT LEG AND THIGH RESTRAINTS

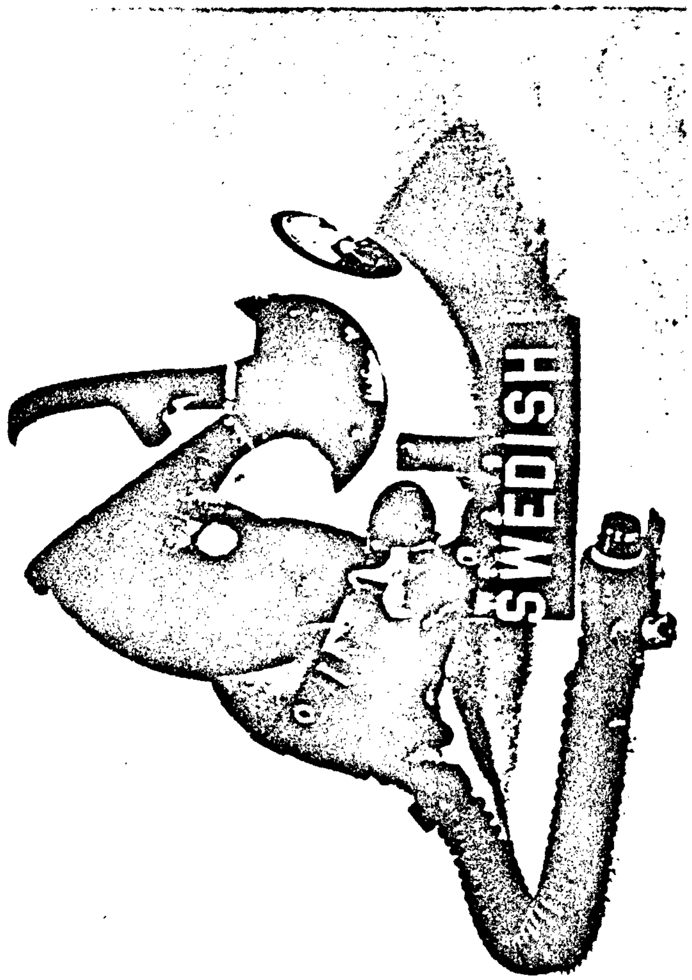


FIGURE A-4: HEAVY 113-B HELMET

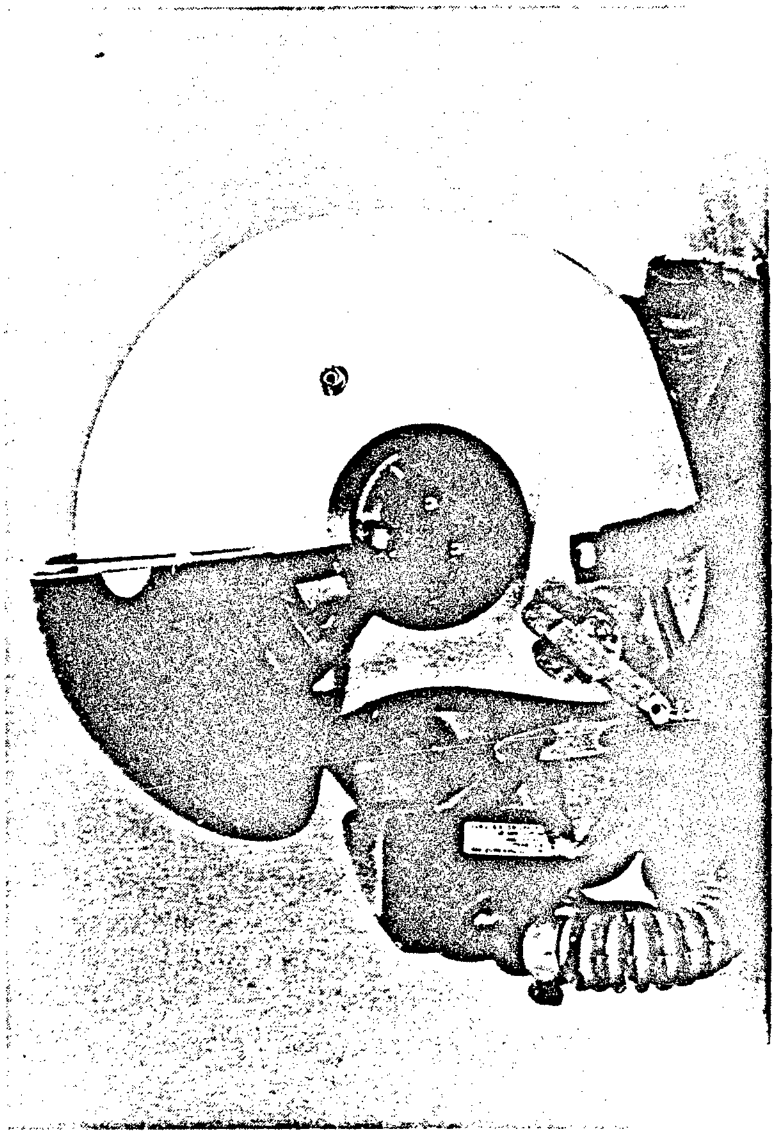
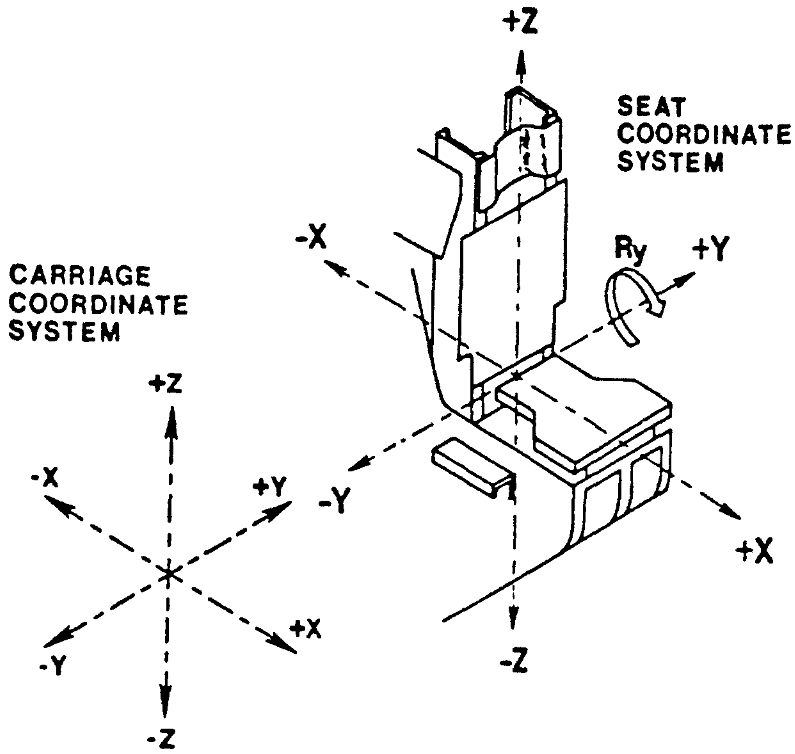


FIGURE A-5: LIGHT 116 HELMET



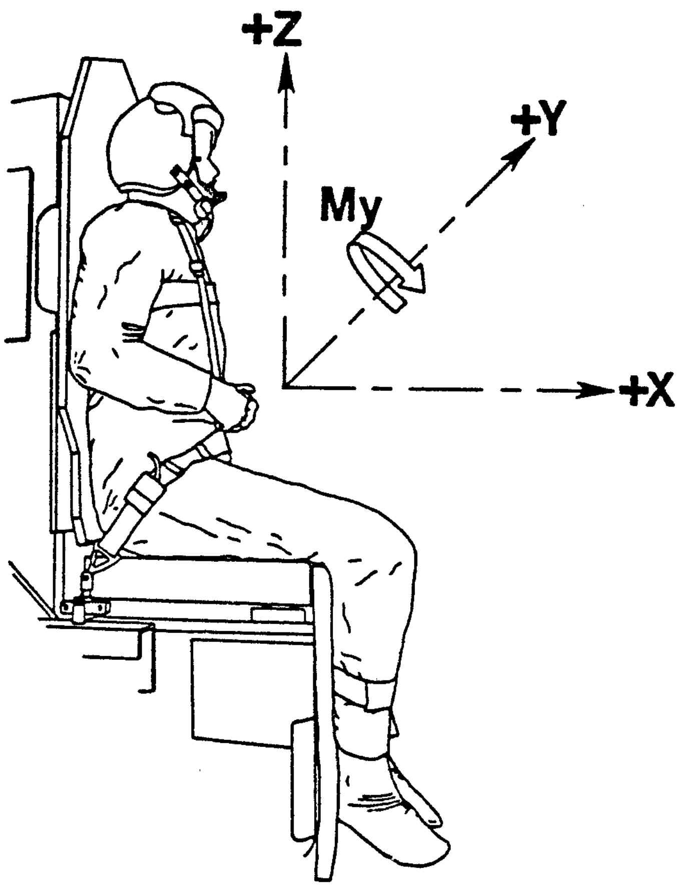
1. ALL TRANSDUCERS EXCEPT THE CARRIAGE ACCELEROMETERS AND THE CARRIAGE VELOCITY TACHOMETER WERE REFERENCED TO THE SEAT COORDINATE SYSTEM. THE CARRIAGE TACHOMETER WAS WIRED TO PROVIDE A POSITIVE OUTPUT VOLTAGE DURING FREEFALL. THE CARRIAGE ACCELEROMETERS WERE REFERENCED TO THE CARRIAGE COORDINATE SYSTEM.

2. THE LINEAR ACCELEROMETERS WERE WIRED TO PROVIDE A POSITIVE OUTPUT VOLTAGE WHEN THE ACCELERATION EXPERIENCED BY THE ACCELEROMETER WAS APPLIED IN THE +x, +y OR +z DIRECTION AS SHOWN.

3. THE ANGULAR Ry ACCELEROMETERS WERE WIRED TO PROVIDE A POSITIVE OUTPUT VOLTAGE WHEN THE ANGULAR ACCELERATION EXPERIENCED BY THE ANGULAR ACCELEROMETER WAS APPLIED IN THE +y DIRECTION ACCORDING TO THE RIGHT HAND RULE AS SHOWN.

4. THE LOAD CELLS AND LOAD LINKS WERE WIRED TO PROVIDE A POSITIVE OUTPUT VOLTAGE WHEN THE FORCE EXERTED BY THE LOAD CELL ON THE SUBJECT WAS APPLIED IN THE +x, +y OR +z DIRECTION AS SHOWN.

FIGURE A-6: AL/CFBE COORDINATE SYSTEM



1. THE ADAM MANIKIN FORCES AND TORQUES WERE REFERENCED TO THE MANIKIN COORDINATE SYSTEM.

2. THE NECK LOAD CELL WAS WIRED TO PROVIDE A POSITIVE OUTPUT VOLTAGE WHEN THE FORCE EXERTED BY THE LOAD CELL, ON THE NECK, WAS APPLIED IN THE +x. +y OR +z DIRECTION AS SHOWN.

3. THE My TORQUE TRANSDUCER WAS WIRED TO PROVIDE A POSITIVE OUTPUT VOLTAGE WHEN THE TORQUE EXPERIENCED BY THE TRANSDUCER WAS APPLIED IN THE +y DIRECTION ACCORDING TO THE RIGHT HAND RULE AS SHOWN.

FIGURE A-7: MANIKIN COORDINATE SYSTEM

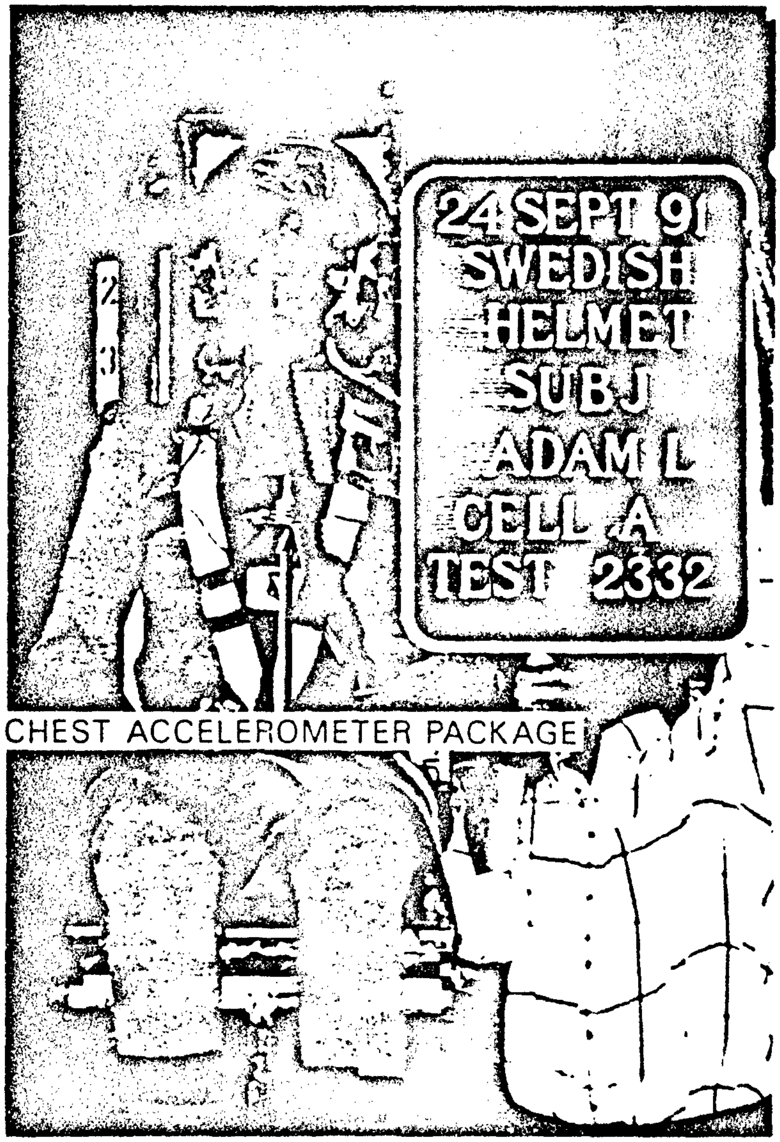
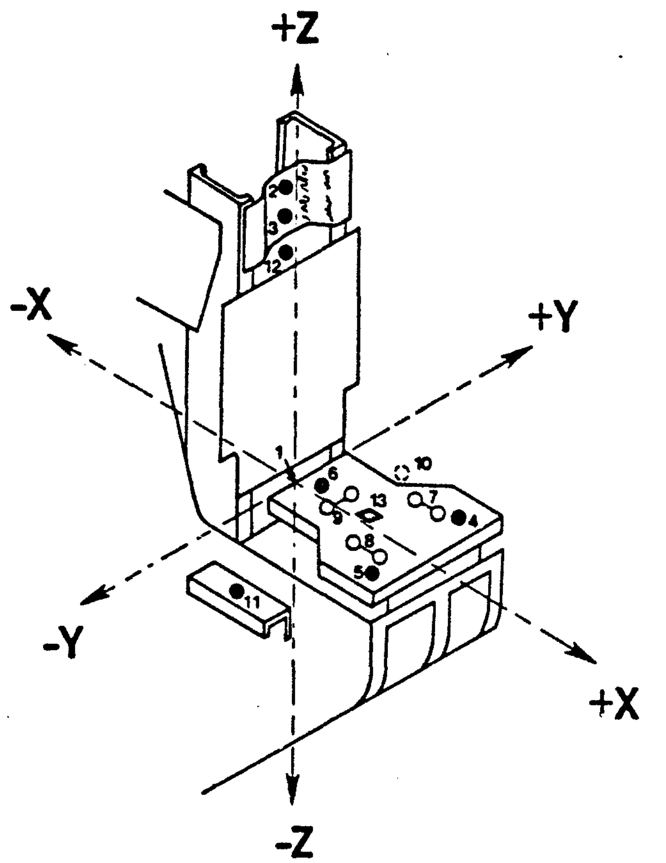


FIGURE A-8: CHEST ACCELEROMETER PACKAGE



NO.	DESCRIPTION	NO.	DESCRIPTION
1	SEAT REFERENCE POINT	8	RIGHT SEAT X FORCE
2	UPPER HEADREST X FORCE	9	CENTER SEAT Y FORCE
3	LOWER HEADREST X FORCE	10	LEFT LAP BELT FORCE
4	LEFT SEAT Z FORCE	11	RIGHT LAP BELT FORCE
5	RIGHT SEAT Z FORCE	12	SHOULDER FORCE
6	CENTER SEAT Z FORCE	13	SEAT X, Y & Z ACCELERATION
7	LEFT SEAT X FORCE		

ITEM 10 NOT SHOWN

THE HEADREST WAS ADJUSTABLE UP OR DOWN DEPENDING ON EACH SUBJECT. HEADREST LOAD CELL NUMBERS 2 AND 3 MOVE WITH THE HEADREST. THE MEASUREMENTS FOR THE HEADREST LOAD CELLS WERE TAKEN WHEN THE TOP MOUNTING HOLES IN THE HEAD REST WERE LINED UP WITH THE TOP HOLES IN THE FRAME SUPPORT.

FIGURE A-9a TRANSDUCER LOCATIONS AND DIMENSIONS (PAGE 1 OF 2)

ALL DIMENSIONS ARE REFERENCED TO THE SEAT REFERENCE POINT (SRP). THE SEAT REFERENCE POINT IS LOCATED AT THE INTERSECTION OF THE SEAT PAN CENTER LINE AND THE SEAT BACK CENTER LINE (z AXIS).

CONTACT POINT DIMENSIONS IN INCHES (CM)

NO.	X	Y	Z
1	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	- 0.31 (- 0.80)	0.00 (0.00)	37.38 (94.95)
3	- 0.31 (- 0.80)	0.00 (0.00)	32.47 (82.48)
4	17.90 (45.46)	5.00 (12.70)	- 1.22 (- 3.10)
5	17.90 (45.46)	- 5.00 (-12.70)	- 1.22 (- 3.10)
6	6.68 (16.96)	0.00 (0.00)	- 1.22 (- 3.10)
7	10.00 (25.41)	6.00 (15.25)	- 1.85 (- 4.70)
8	10.00 (25.41)	- 6.00 (-15.25)	- 1.85 (- 4.70)
9	9.26 (23.51)	1.99 (5.05)	- 1.85 (- 4.70)
10	0.81 (2.06)	9.00 (22.86)	- 1.61 (- 4.10)
11	0.81 (2.06)	- 9.00 (-22.86)	- 1.61 (- 4.10)
12	- 5.47 (-13.90)	0.00 (0.00)	27.39 (69.58)
13	12.33 (31.31)	0.00 (0.00)	- 1.69 (- 4.30)

(SEE FIGURE A-9a FOR DESCRIPTIONS OF TRANSDUCER ITEM NUMBERS)

THE SEAT ACCELEROMETER MEASUREMENTS (ITEM 13) ARE TAKEN AT THE CENTER OF THE ACCELEROMETER BLOCK.

THE CONTACT POINT IS THE POINT ON THE LOAD CELL AT WHICH THE EXTERNAL FORCE IS APPLIED.

THE MEASUREMENTS FOR THE LOAD CELLS WHICH ANCHOR THE HARNESS (ITEMS 10, 11 & 12) ARE TAKEN AT THE POINT WHERE THE HARNESS IS ATTACHED TO THE LOAD CELL.

FIGURE A-9b: TRANSDUCER LOCATIONS AND DIMENSIONS (PAGE 2 OF 2)

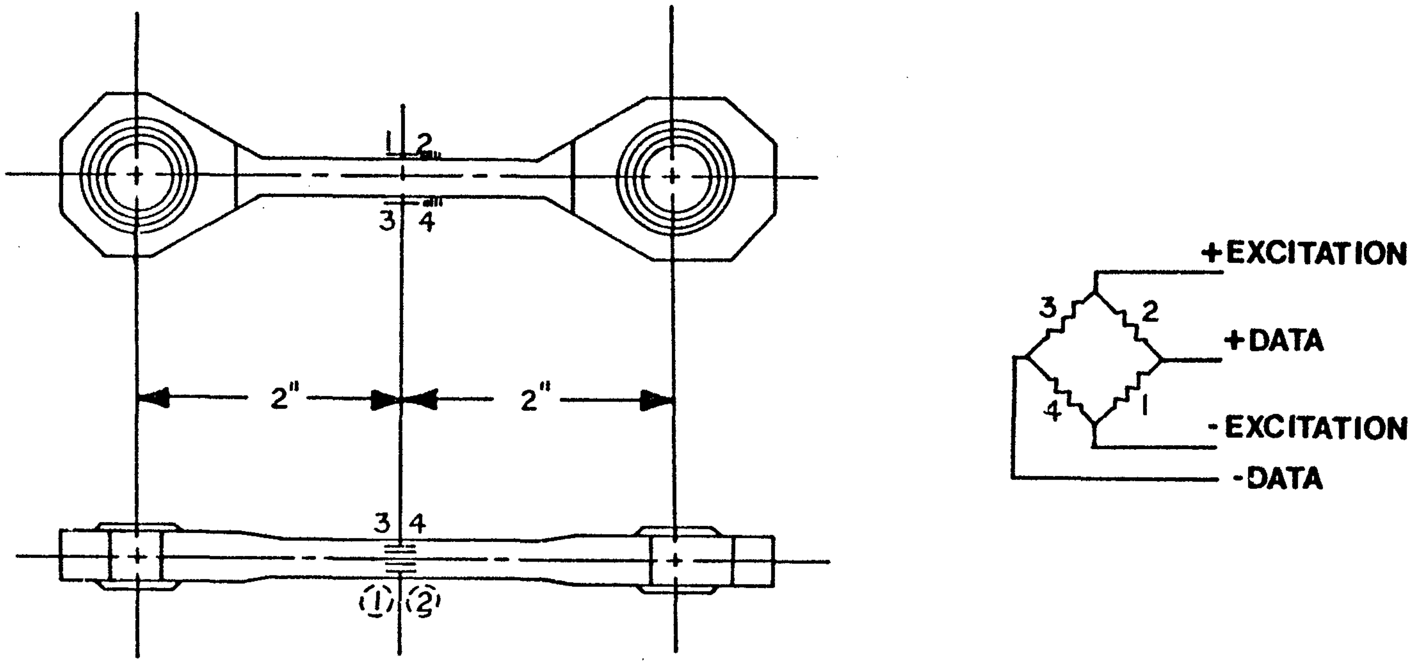
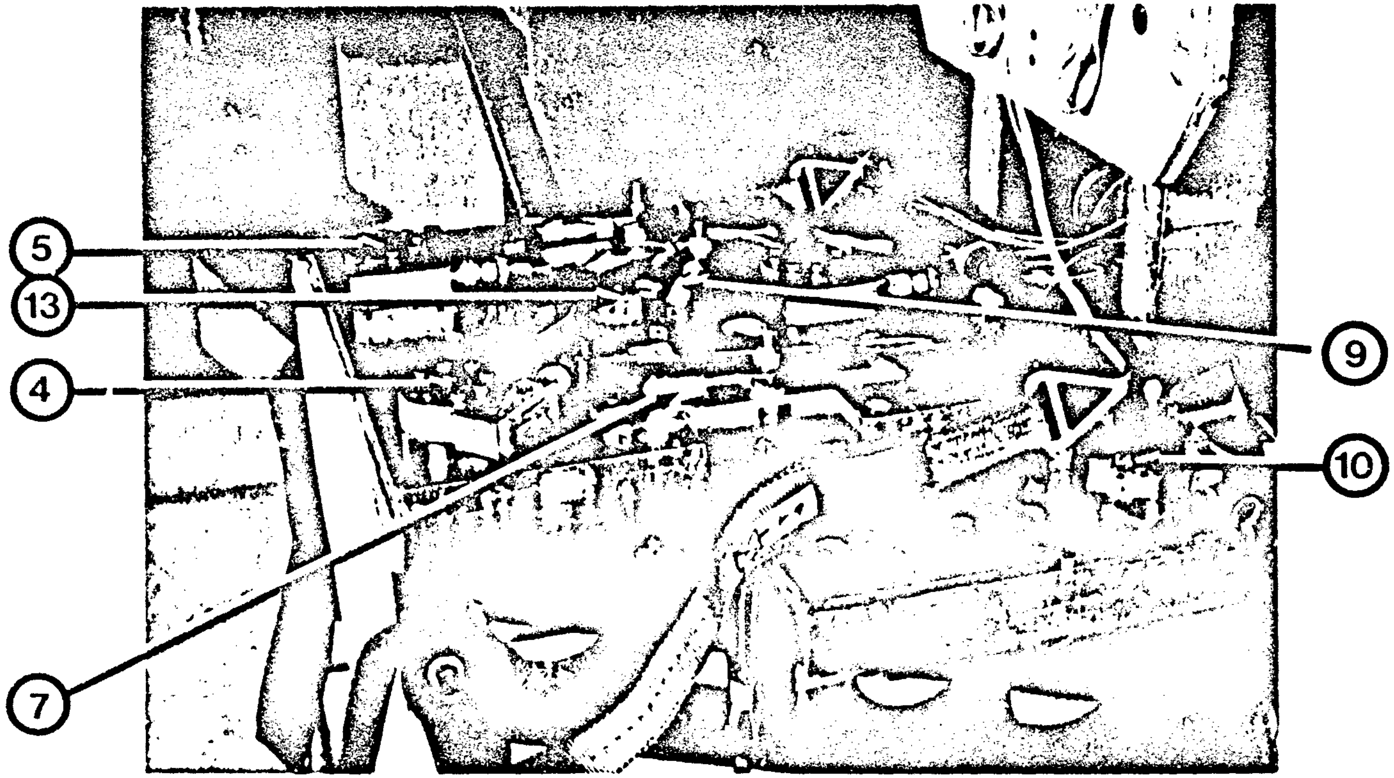
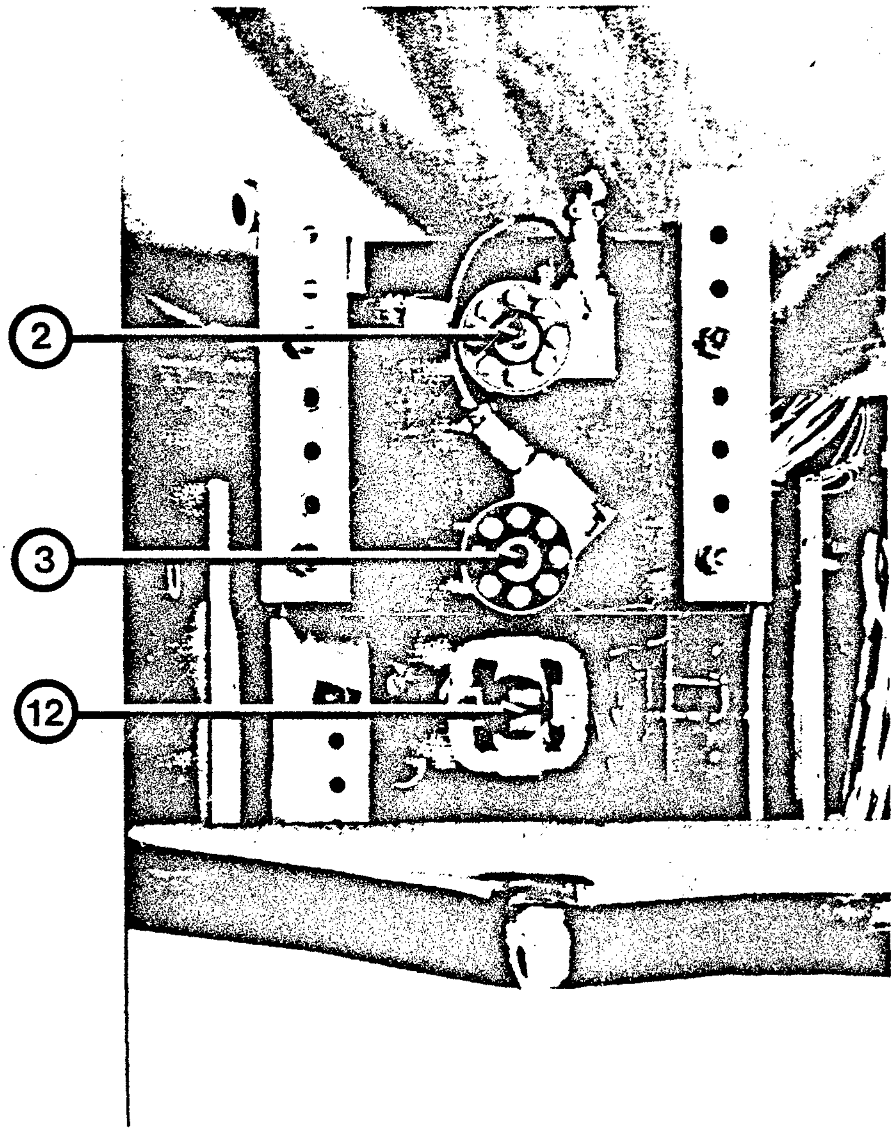


FIGURE A-10: LOAD LINK INSTRUMENTATION



NOTE: REFER TO FIGURE A-9a FOR A DESCRIPTION OF THE TRANSDUCER ITEM NUMBERS.

FIGURE A-11: SEAT PAN INSTRUMENTATION



NOTE: REFER TO FIGURE A-9a FOR A DESCRIPTION OF THE TRANSDUCER ITEM NUMBERS.

FIGURE A-12: HEADREST AND SHOULDER LOAD CELL INSTRUMENTATION

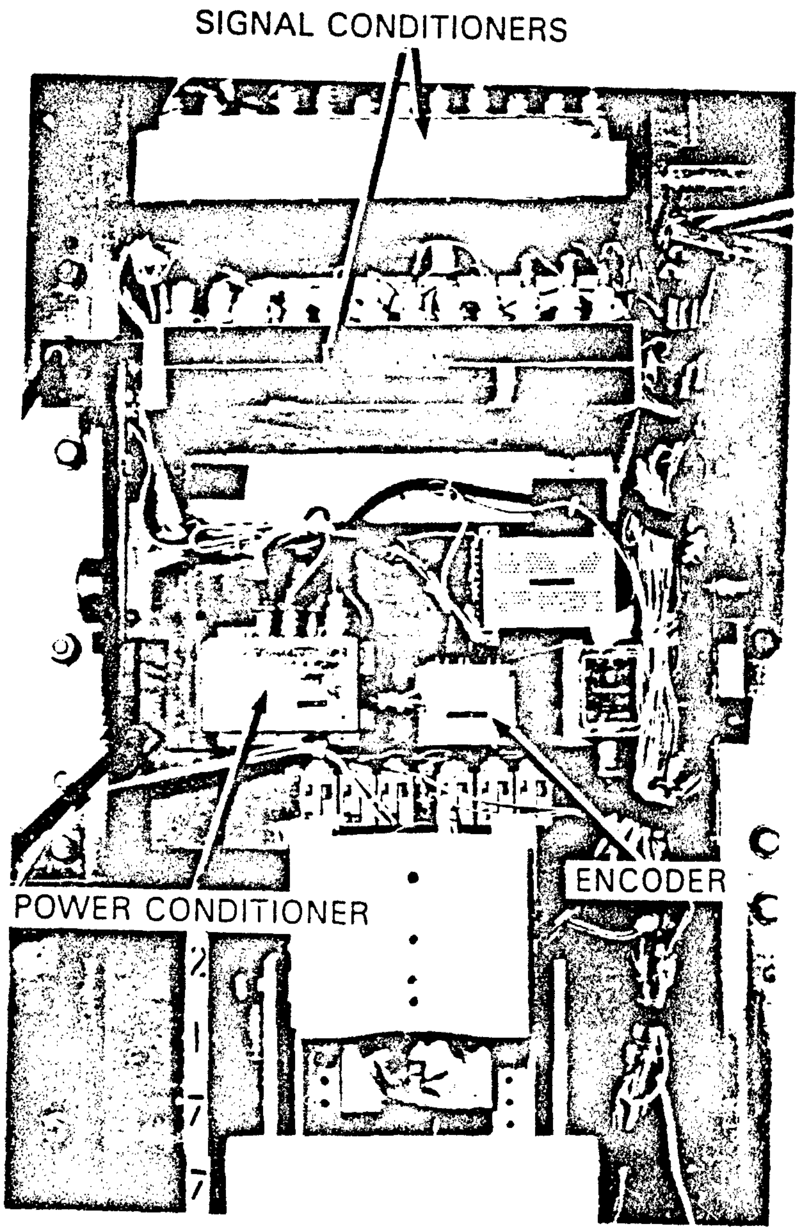


FIGURE A-13: ADACS INSTALLATION

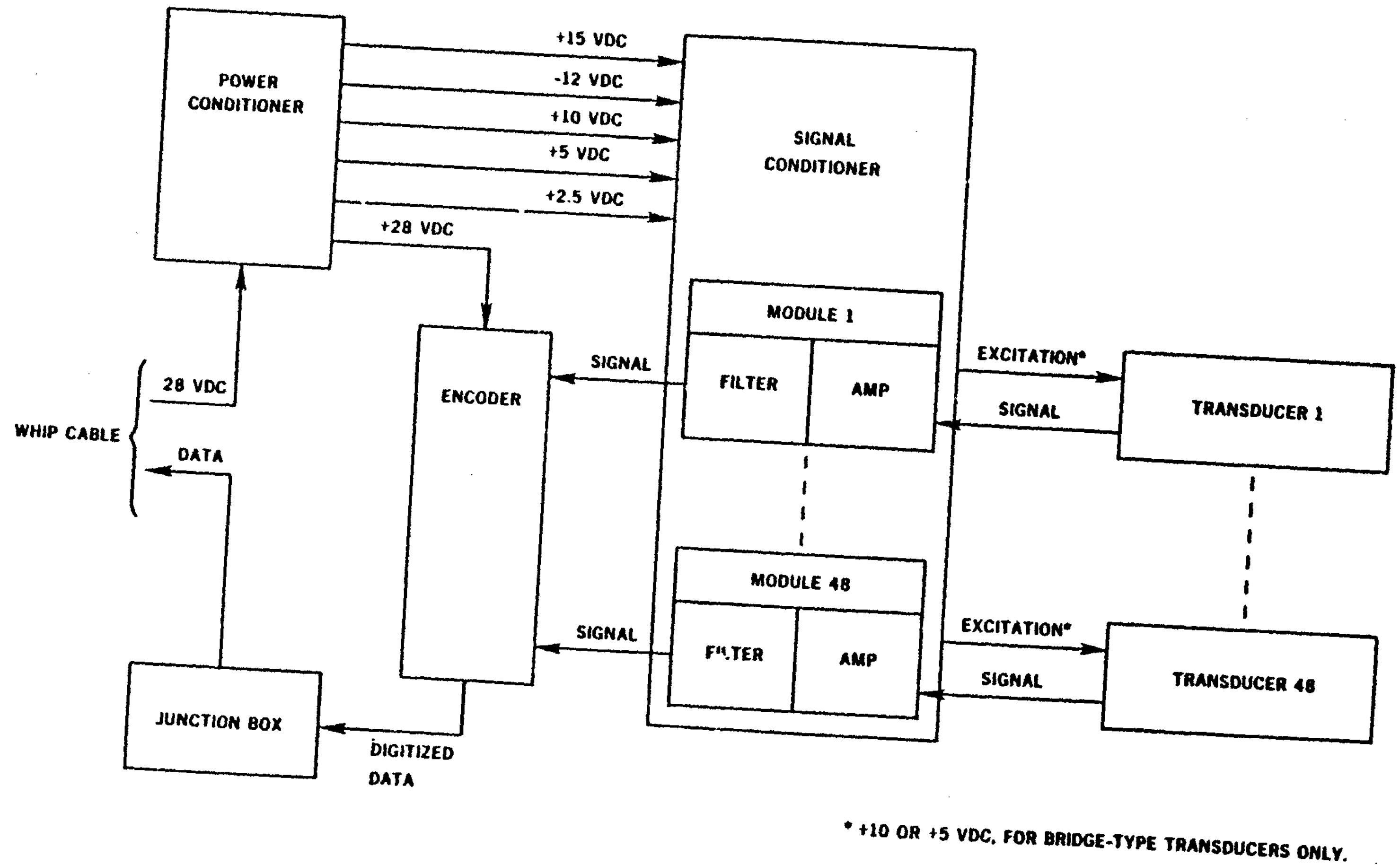


FIGURE A-14: AUTOMATIC DATA ACQUISITION AND CONTROL SYSTEM

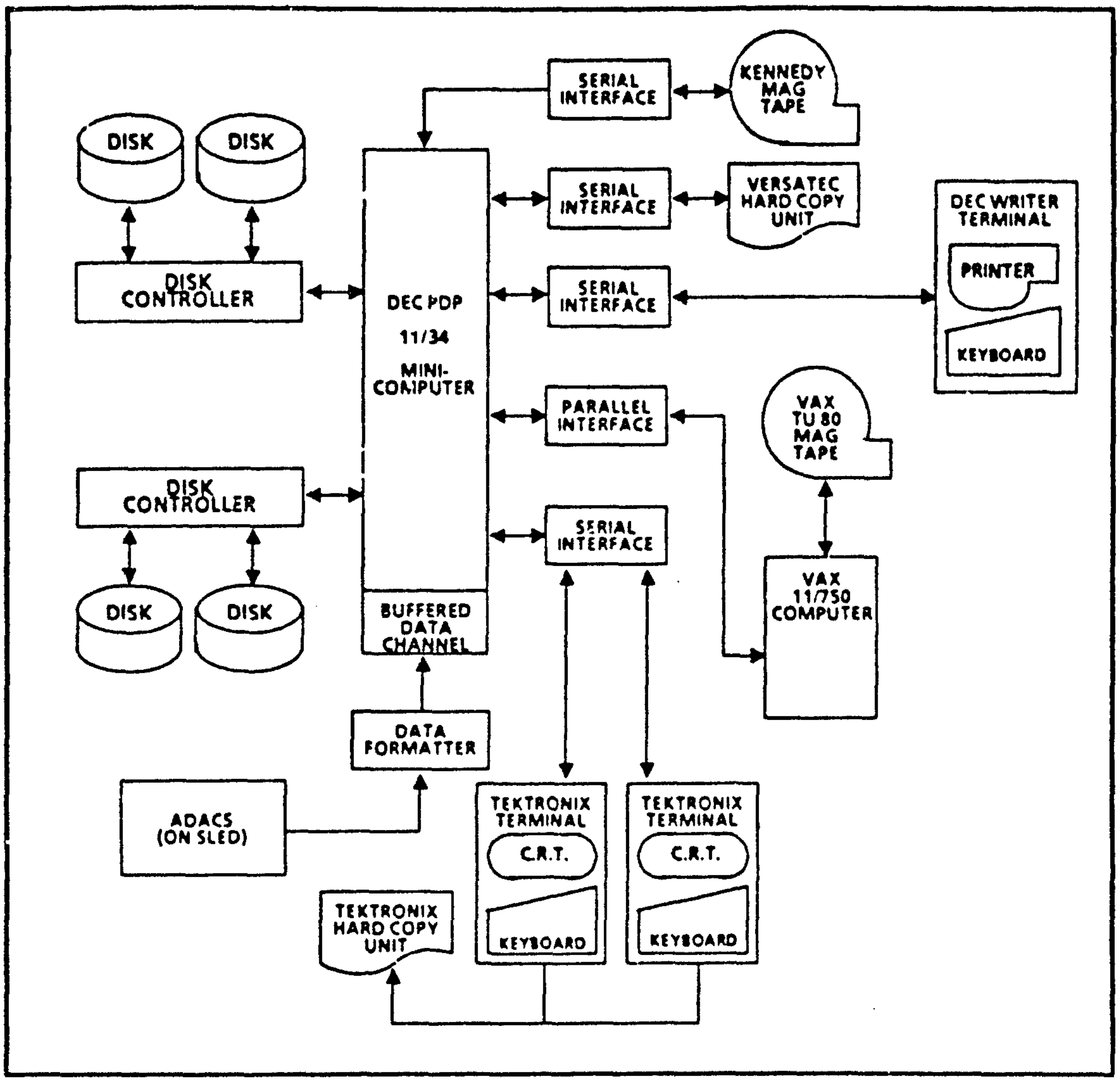


FIGURE A-15: DATA ACQUISITION AND STORAGE SYSTEM BLOCK DIAGRAM

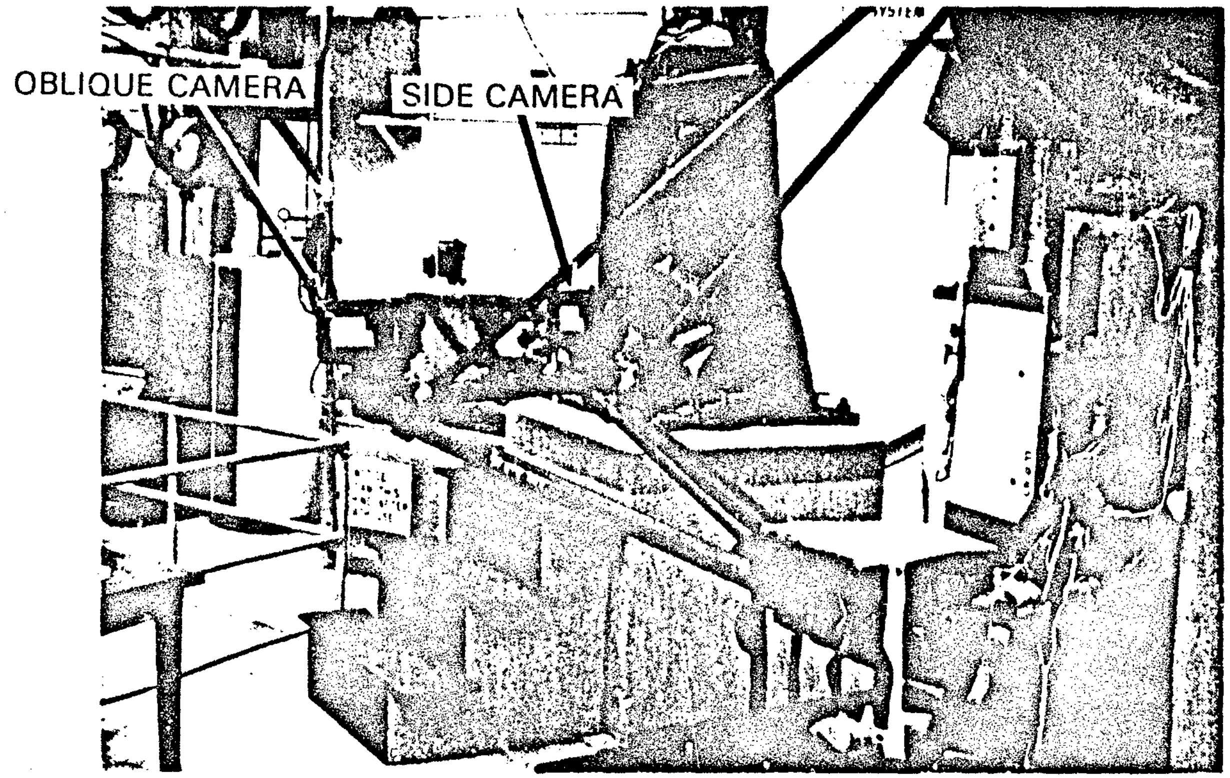


FIGURE A-16: ONBOARD SELSPOT CAMERA LOCATIONS

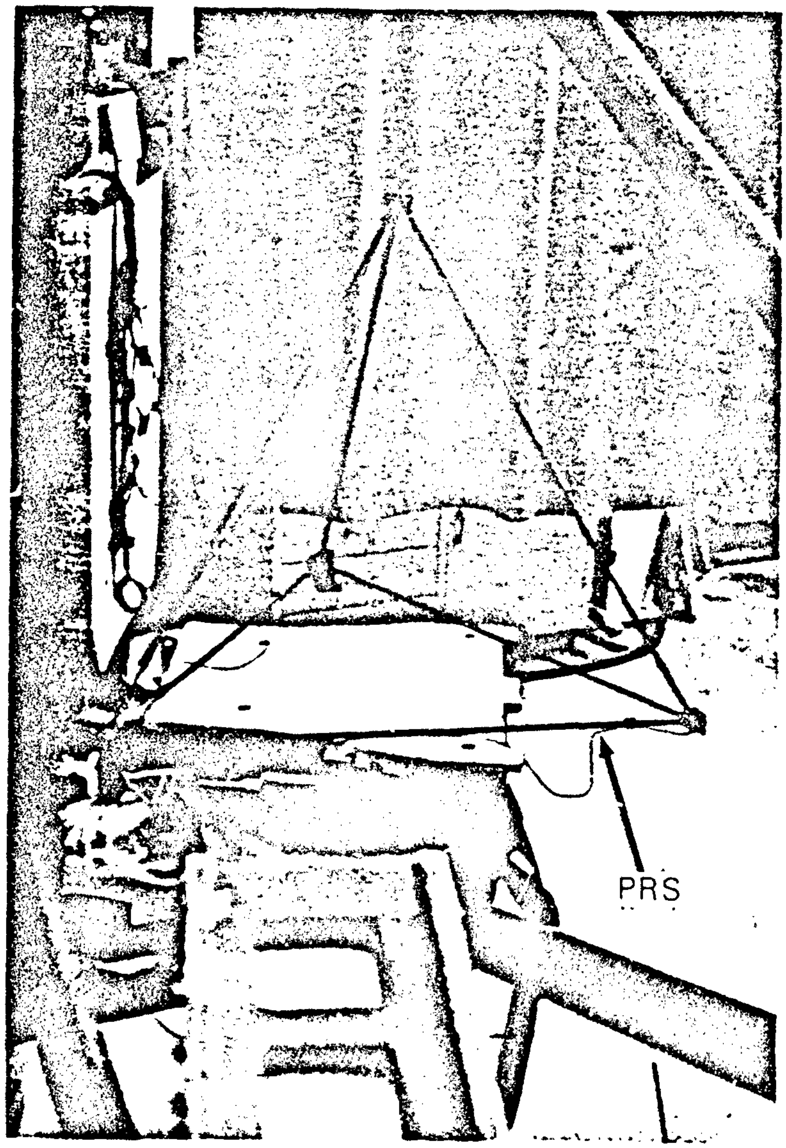
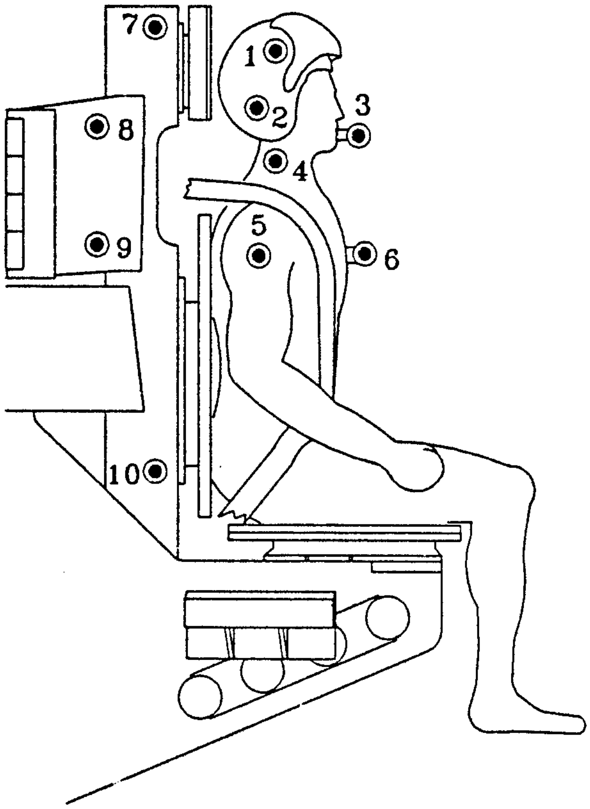


FIGURE A-17: POSITION REFERENCE STRUCTURE (PRS)



ALL DIMENSIONS ARE REFERENCED TO THE SEAT REFERENCE POINT (SRP). THE SEAT REFERENCE POINT IS LOCATED AT THE INTERSECTION OF THE SEAT PAN CENTER LINE AND THE SEAT BACK CENTER LINE (z AXIS).

	DESCRIPTION	DIMENSIONS IN MILLIMETERS		
		X	Y	Z
1.	HELMET TOP	-	-	-
2.	HELMET BOTTOM	-	-	-
3.	MOUTH	-	-	-
4.	NECK	-	-	-
5.	SHOULDER	-	-	-
6.	CHEST	-	-	-
7.	UPPER FRAME	- 43.00	-164.55	+1034.90
8.	UPPER NUMBER PLATE	-243.20	-240.40	+ 818.50
9.	LOWER NUMBER PLATE	-250.70	-240.90	+ 553.60
10.	LOWER FRAME	-110.70	-201.65	+ 251.70

FIGURE A-18: INFRARED TARGET (LED) LOCATIONS

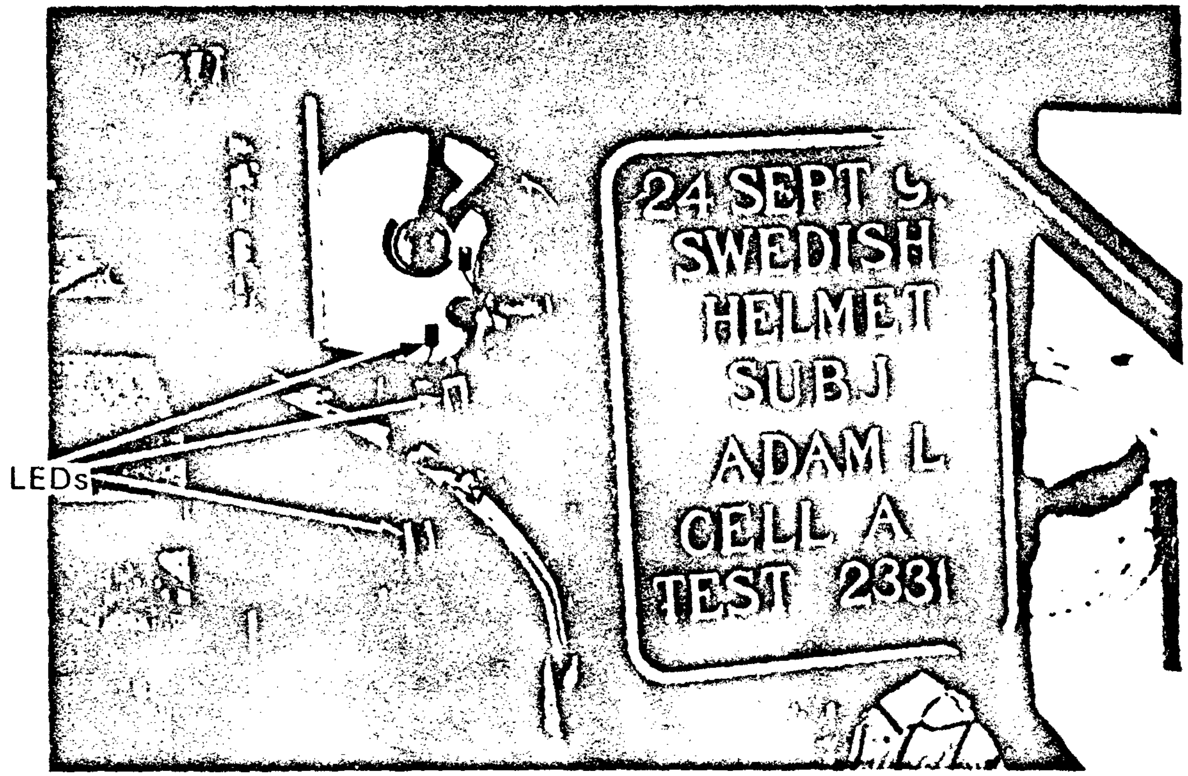


FIGURE A-19: INFRARED TARGETS

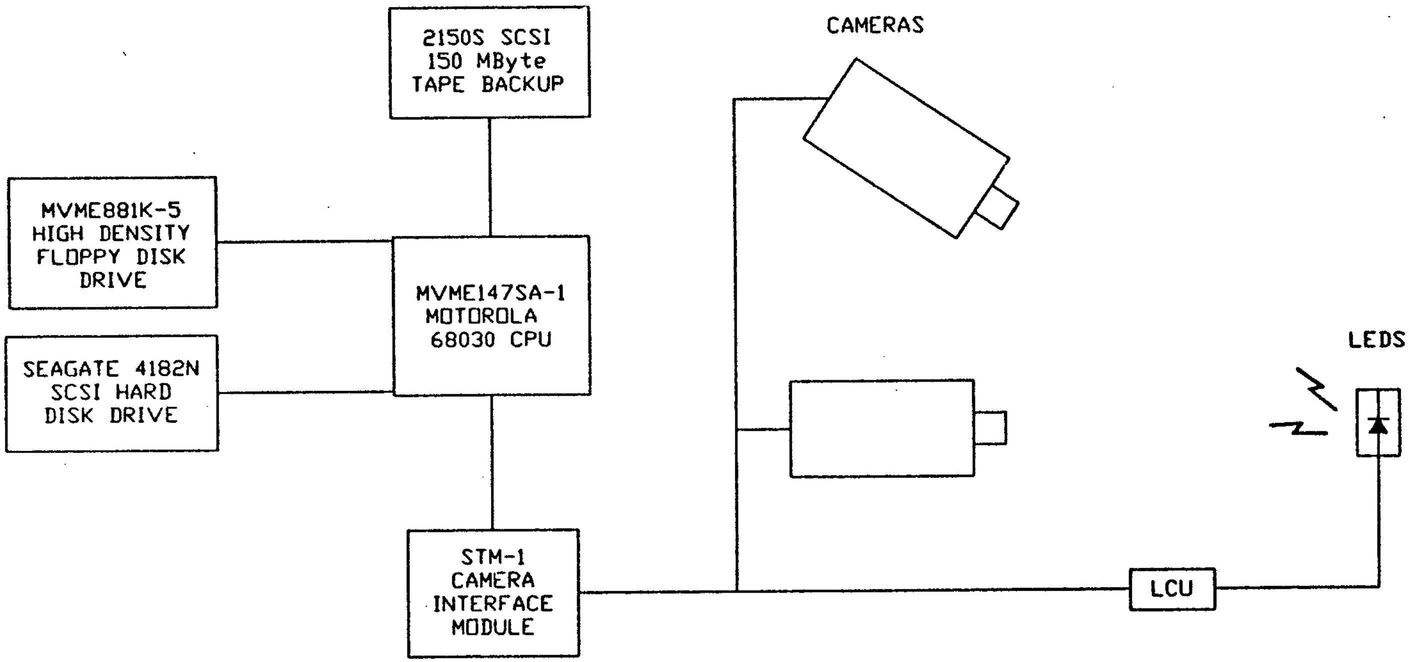


FIGURE A-20: SELSPOT MOTION ANALYSIS SYSTEM

APPENDIX B

TEST SUMMARY DATA

SH STUDY TEST: 2330 SUBJ: ADAM-L WT: 216.0 NOM G: 8.0 CELL: A

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	5.59	6.23	-4.80	15.	88.
LOWER X AXIS	-3.59	4.66	-4.66	57.	9.
X AXIS SUM	2.00	7.18	-8.22	126.	119.
LAP FORCES (LB)					
LEFT X AXIS	-21.19	-0.48	-26.04	50.	172.
LEFT Y AXIS	3.82	5.42	-5.42	4.	54.
LEFT Z AXIS	-28.40	11.69	-29.50	71.	166.
LEFT RESULTANT	35.66	39.72	3.80	172.	50.
RIGHT X AXIS	-20.69	-0.91	-30.37	50.	169.
RIGHT Y AXIS	0.51	4.13	-1.61	68.	53.
RIGHT Z AXIS	-23.61	23.53	-31.29	76.	177.
RIGHT RESULTANT	31.41	43.63	5.84	177.	37.
SEAT FORCES (LB)					
LEFT X AXIS	-5.73	79.79	-10.14	98.	8.
RIGHT X AXIS	-4.47	34.67	-80.45	25.	83.
X AXIS SUM	-10.20	66.22	-31.93	97.	129.
Y AXIS	-0.69	165.69	-3.21	74.	16.
LEFT Z AXIS	-4.45	301.34	-6.28	75.	1.
RIGHT Z AXIS	-4.79	252.49	-6.25	69.	0.
CENTER Z AXIS	42.77	2036.95	55.31	76.	0.
Z AXIS SUM	33.53	2505.59	42.79	76.	1.
RESULTANT	35.08	2509.57	42.91	76.	5.
Z SUM MINUS TARE	52.44	2369.65	49.11	76.	5.
RESULTANT MINUS TARE	53.43	2370.16	49.22	76.	5.
ADAM NECK FORCE (LB)					
X AXIS	1.23	45.54	-30.46	86.	184.
Y AXIS	1.12	12.16	-6.26	77.	114.
Z AXIS	-17.73	143.15	-15.25	85.	0.
RESULTANT	17.88	149.39	0.87	85.	272.
ADAM NECK MY (IN-LB)	11.14	66.85	-37.15	176.	110.

SH STUDY TEST: 2331 SUBJ: ADAM-L WT: 216.0 NOM G: 8.0 CELL: A

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	1.23	3.70	-10.39	20.	61.
LOWER X AXIS	-0.02	9.95	-0.62	58.	14.
X AXIS SUM	1.20	8.75	-7.93	58.	55.
LAP FORCES (LB)					
LEFT X AXIS	-19.64	1.60	-23.96	59.	160.
LEFT Y AXIS	7.41	12.82	-5.24	174.	55.
LEFT Z AXIS	-28.41	11.37	-31.40	71.	172.
LEFT RESULTANT	35.33	40.56	2.61	172.	51.
RIGHT X AXIS	-20.89	1.86	-36.67	60.	178.
RIGHT Y AXIS	3.47	13.76	-3.47	82.	56.
RIGHT Z AXIS	-24.75	20.21	-36.57	72.	165.
RIGHT RESULTANT	32.58	51.99	6.16	178.	27.
SEAT FORCES (LB)					
LEFT X AXIS	-11.25	82.87	-9.31	90.	0.
RIGHT X AXIS	-5.11	34.70	-99.99	70.	80.
X AXIS SUM	-16.36	45.23	-47.47	98.	80.
Y AXIS	-8.79	54.68	-32.11	70.	114.
LEFT Z AXIS	-3.84	209.37	-6.28	70.	1.
RIGHT Z AXIS	-3.24	381.10	-3.85	78.	0.
CENTER Z AXIS	44.00	1931.10	49.79	71.	0.
Z AXIS SUM	36.92	2392.20	39.67	71.	1.
RESULTANT	41.37	2393.07	41.62	71.	3.
Z SUM MINUS TARE	55.45	2245.94	51.07	71.	3.
RESULTANT MINUS TARE	57.83	2246.35	52.36	71.	3.
ADAM NECK FORCE (LB)					
X AXIS	1.29	42.56	-36.48	78.	187.
Y AXIS	0.24	6.14	-7.67	74.	127.
Z AXIS	-12.40	143.31	-12.40	82.	0.
RESULTANT	12.57	148.69	1.02	82.	25.
ADAM NECK MY (IN-LB)	4.00	89.14	-37.15	172.	106.

SH STUDY TEST: 2332 SUBJ: ADAM-L WT: 216.0 NOM G: 8.0 CELL: A

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	2.41	3.64	-8.62	19.	76.
LOWER X AXIS	-2.78	6.38	-3.57	59.	11.
X AXIS SUM	-0.36	5.07	-9.73	50.	57.
LAP FORCES (LB)					
LEFT X AXIS	-18.56	1.50	-30.88	60.	172.
LEFT Y AXIS	4.92	9.57	-4.88	170.	57.
LEFT Z AXIS	-24.56	14.99	-35.71	77.	171.
LEFT RESULTANT	31.20	47.84	3.05	172.	53.
RIGHT X AXIS	-20.63	-1.45	-46.78	50.	178.
RIGHT Y AXIS	-0.35	4.07	-3.97	68.	179.
RIGHT Z AXIS	-27.34	13.63	-50.99	93.	174.
RIGHT RESULTANT	34.27	67.82	5.63	178.	48.
SEAT FORCES (LB)					
LEFT X AXIS	-8.80	62.37	-17.45	82.	12.
RIGHT X AXIS	-11.22	39.78	-96.06	37.	83.
X AXIS SUM	-20.02	47.07	-45.83	37.	122.
Y AXIS	-3.11	170.12	-2.30	75.	0.
LEFT Z AXIS	-4.08	263.28	-6.28	76.	1.
RIGHT Z AXIS	-4.83	294.08	-5.68	70.	0.
CENTER Z AXIS	41.60	2031.69	50.04	76.	0.
Z AXIS SUM	32.69	2488.08	41.26	76.	0.
RESULTANT	38.72	2493.14	42.56	76.	0.
Z SUM MINUS TARE	50.84	2357.66	52.40	76.	0.
RESULTANT MINUS TARE	54.75	2357.71	53.38	76.	0.
ADAM NECK FORCE (LB)					
X AXIS	4.96	45.29	-33.74	82.	186.
Y AXIS	0.56	9.18	-6.17	78.	134.
Z AXIS	-13.22	147.66	-10.74	85.	0.
RESULTANT	14.20	154.57	2.74	86.	27.
ADAM NECK MY (IN-LB)	8.00	96.57	-44.58	179.	106.

SH STUDY TEST: 2333 SUBJ: ADAM-L WT: 216.0 NOM G: 10.0 CELL: B

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	3.60	5.44	-11.10	24.	69.
LOWER X AXIS	-1.95	9.96	-1.85	55.	1.
X AXIS SUM	1.66	9.89	-11.09	55.	69.
LAP FORCES (LB)					
LEFT X AXIS	-18.73	3.82	-37.09	56.	156.
LEFT Y AXIS	2.02	7.44	-5.20	161.	52.
LEFT Z AXIS	-29.81	17.77	-53.51	67.	164.
LEFT RESULTANT	35.27	65.35	3.08	164.	39.
RIGHT X AXIS	-21.67	0.82	-30.91	57.	164.
RIGHT Y AXIS	0.01	7.74	-2.60	64.	155.
RIGHT Z AXIS	-27.60	19.62	-33.25	56.	165.
RIGHT RESULTANT	35.10	45.42	5.26	166.	107.
SEAT FORCES (LB)					
LEFT X AXIS	-0.75	60.77	-23.54	93.	64.
RIGHT X AXIS	-2.46	73.56	-57.67	64.	111.
X AXIS SUM	-3.22	90.94	-63.23	87.	112.
Y AXIS	0.80	183.91	-7.27	63.	26.
LEFT Z AXIS	-3.47	440.88	-6.28	68.	9.
RIGHT Z AXIS	-3.39	232.17	-4.48	59.	0.
CENTER Z AXIS	44.98	2671.33	50.04	66.	0.
Z AXIS SUM	38.12	3221.25	42.46	66.	0.
RESULTANT	38.36	3224.60	43.68	66.	0.
Z SUM MINUS TARE	57.06	3055.00	51.40	66.	4.
RESULTANT MINUS TARE	57.22	3055.10	52.43	66.	4.
ADAM NECK FORCE (LB)					
X AXIS	0.14	58.24	-45.11	72.	181.
Y AXIS	0.89	9.21	-3.07	192.	55.
Z AXIS	-9.81	201.46	-10.63	75.	0.
RESULTANT	9.93	208.97	0.50	75.	24.
ADAM NECK MY (IN-LB)	6.99	118.71	-74.44	175.	102.

SH STUDY TEST: 2335 SUBJ: ADAM-L WT: 216.0 NOM G: 10.0 CELL: B

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-1.05	1.88	-15.89	197.	69.
LOWER X AXIS	0.00	11.19	-0.62	55.	145.
X AXIS SUM	-1.05	10.00	-11.61	56.	53.
LAP FORCES (LB)					
LEFT X AXIS	-20.52	1.70	-42.61	57.	169.
LEFT Y AXIS	0.74	7.55	-6.90	162.	50.
LEFT Z AXIS	-28.72	18.57	-54.31	67.	167.
LEFT RESULTANT	35.31	69.26	5.34	169.	32.
RIGHT X AXIS	-22.36	-2.31	-36.31	47.	151.
RIGHT Y AXIS	-1.19	3.63	-4.41	63.	151.
RIGHT Z AXIS	-22.18	23.53	-35.20	55.	165.
RIGHT RESULTANT	31.53	50.68	9.41	165.	27.
SEAT FORCES (LB)					
LEFT X AXIS	-0.72	57.73	-29.95	93.	64.
RIGHT X AXIS	1.80	80.26	-115.44	64.	74.
X AXIS SUM	1.08	64.59	-88.06	87.	74.
Y AXIS	0.04	187.67	-2.35	64.	14.
LEFT Z AXIS	-6.34	428.13	-9.51	66.	5.
RIGHT Z AXIS	-4.96	245.04	-7.38	59.	3.
CENTER Z AXIS	39.89	2554.81	46.41	67.	0.
Z AXIS SUM	28.60	3104.88	35.84	67.	0.
RESULTANT	28.80	3107.15	35.85	67.	0.
Z SUM MINUS TARE	47.81	2896.05	42.46	67.	3.
RESULTANT MINUS TARE	47.94	2896.23	42.52	67.	3.
ADAM NECK FORCE (LB)					
X AXIS	-2.52	54.65	-51.74	75.	178.
Y AXIS	-0.67	4.70	-7.58	151.	304.
Z AXIS	-13.38	195.82	-13.58	77.	1.
RESULTANT	13.71	201.76	0.20	77.	434.
ADAM NECK MY (IN-LB)	0.14	118.71	-74.43	167.	103.

SH STUDY TEST: 2336 SUBJ: ADAM-L WT: 216.0 NOM G: 15.0 CELL: C

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	0.57	2.67	-16.94	173.	52.
LOWER X AXIS	-0.02	16.76	-0.02	49.	0.
X AXIS SUM	0.55	13.92	-13.25	49.	51.
LAP FORCES (LB)					
LEFT X AXIS	-23.30	3.44	-74.95	51.	131.
LEFT Y AXIS	6.10	23.26	-5.64	125.	47.
LEFT Z AXIS	-30.44	26.90	-90.33	61.	133.
LEFT RESULTANT	38.83	118.60	7.58	133.	27.
RIGHT X AXIS	-25.43	2.90	-74.15	42.	130.
RIGHT Y AXIS	-0.80	4.55	-6.94	57.	142.
RIGHT Z AXIS	-28.21	27.29	-76.48	49.	130.
RIGHT RESULTANT	38.00	106.63	6.53	130.	24.
SEAT FORCES (LB)					
LEFT X AXIS	-2.11	221.59	-32.46	68.	131.
RIGHT X AXIS	0.54	78.60	-181.57	47.	59.
X AXIS SUM	-1.57	151.12	-155.44	74.	56.
Y AXIS	-0.71	194.54	-18.93	48.	54.
LEFT Z AXIS	-4.22	462.57	-6.79	48.	3.
RIGHT Z AXIS	-4.31	556.85	-4.80	70.	1.
CENTER Z AXIS	47.92	4447.28	51.30	65.	0.
Z AXIS SUM	39.38	5226.27	42.89	65.	1.
RESULTANT	39.56	5227.13	44.23	65.	1.
Z SUM MINUS TARE	57.08	4997.10	53.57	65.	8.
RESULTANT MINUS TARE	57.19	4997.39	57.19	65.	3.
ADAM NECK FORCE (LB)					
X AXIS	-1.36	99.89	-76.42	71.	171.
Y AXIS	-0.71	9.21	-12.28	177.	88.
Z AXIS	-12.18	324.85	-24.16	62.	137.
RESULTANT	12.39	334.24	0.43	62.	22.
ADAM NECK MY (IN-LB)	1.19	224.05	-132.53	162.	94.

SH STUDY TEST: 2337 SUBJ: ADAM-L WT: 216.0 NOM G: 15.0 CELL: C

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-0.18	13.63	-20.69	377.	52.
LOWER X AXIS	-0.37	23.97	-0.90	378.	2.
X AXIS SUM	-0.55	37.60	-15.37	378.	52.
LAP FORCES (LB)					
LEFT X AXIS	-22.25	0.89	-67.28	41.	122.
LEFT Y AXIS	4.79	17.99	-7.30	125.	45.
LEFT Z AXIS	-30.64	31.94	-85.29	53.	128.
LEFT RESULTANT	38.19	110.12	4.59	130.	28.
RIGHT X AXIS	-22.98	6.57	-70.48	50.	139.
RIGHT Y AXIS	-3.17	4.25	-11.83	58.	149.
RIGHT Z AXIS	-28.89	28.04	-79.65	52.	138.
RIGHT RESULTANT	37.08	106.89	3.20	140.	18.
SEAT FORCES (LB)					
LEFT X AXIS	4.36	255.00	-38.40	68.	133.
RIGHT X AXIS	0.53	66.86	-131.14	49.	60.
X AXIS SUM	4.89	197.77	-127.60	67.	96.
Y AXIS	0.14	215.82	0.00	64.	118.
LEFT Z AXIS	-4.91	401.87	-7.23	54.	2.
RIGHT Z AXIS	-3.15	514.32	-6.31	69.	132.
CENTER Z AXIS	56.19	4894.28	65.59	65.	0.
Z AXIS SUM	48.12	5541.51	55.21	65.	5.
RESULTANT	48.77	5547.30	58.57	65.	0.
Z SUM MINUS TARE	65.18	5273.12	66.39	65.	2.
RESULTANT MINUS TARE	65.66	5275.18	66.63	65.	2.
ADAM NECK FORCE (LB)					
X AXIS	-1.95	98.25	-71.98	71.	172.
Y AXIS	-0.36	9.03	-9.39	387.	11.
Z AXIS	-10.26	385.74	-19.65	61.	136.
RESULTANT	10.51	392.80	2.08	61.	325.
ADAM NECK MY (IN-LB)	8.30	208.30	-103.70	157.	111.

SH STUDY TEST: 2338 SUBJ: ADAM-L WT: 216.0 NOM G: 15.0 CELL: C

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-0.15	2.87	-22.26	405.	52.
LOWER X AXIS	-0.36	16.09	-1.32	49.	420.
X AXIS SUM	-0.51	16.47	-17.98	406.	52.
LAP FORCES (LB)					
LEFT X AXIS	-22.05	1.81	-66.36	41.	127.
LEFT Y AXIS	6.32	21.53	-3.76	129.	43.
LEFT Z AXIS	-30.46	30.23	-82.25	52.	128.
LEFT RESULTANT	38.15	107.86	6.33	129.	27.
RIGHT X AXIS	-22.66	4.53	-67.99	41.	129.
RIGHT Y AXIS	-2.12	3.49	-9.14	64.	149.
RIGHT Z AXIS	-28.11	30.70	-75.03	51.	131.
RIGHT RESULTANT	36.18	101.57	4.17	138.	24.
SEAT FORCES (LB)					
LEFT X AXIS	-6.76	242.92	-19.00	68.	423.
RIGHT X AXIS	-8.72	52.96	-131.24	23.	60.
X AXIS SUM	-15.48	170.51	-85.87	67.	94.
Y AXIS	-4.38	236.83	-4.79	64.	0.
LEFT Z AXIS	-5.06	380.62	-6.28	54.	0.
RIGHT Z AXIS	-5.56	609.48	-5.81	69.	0.
CENTER Z AXIS	49.09	4810.00	50.30	65.	0.
Z AXIS SUM	38.47	5547.27	38.21	64.	0.
RESULTANT	41.75	5553.12	41.63	64.	0.
Z SUM MINUS TARE	56.71	5294.72	50.07	65.	0.
RESULTANT MINUS TARE	58.80	5296.62	52.51	65.	0.
ADAM NECK FORCE (LB)					
X AXIS	-1.72	98.25	-81.10	70.	171.
Y AXIS	66.46	74.01	27.97	65.	10.
Z AXIS	-10.65	359.32	-21.91	60.	136.
RESULTANT	67.34	374.26	28.21	61.	10.
ADAM NECK MY (IN-LB)	4.66	214.09	-135.05	156.	93.

SH STUDY TEST: 2339 SUBJ: ADAM-L WT: 216.0 NOM G: 20.0 CELL: D

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-0.47	2.48	-31.23	50.	56.
LOWER X AXIS	0.51	23.27	-0.35	37.	267.
X AXIS SUM	0.04	23.26	-22.87	50.	56.
LAP FORCES (LB)					
LEFT X AXIS	-20.76	4.81	-94.04	38.	113.
LEFT Y AXIS	2.88	19.83	-10.87	112.	42.
LEFT Z AXIS	-27.18	42.77	-114.06	44.	116.
LEFT RESULTANT	34.34	148.37	3.92	117.	17.
RIGHT X AXIS	-20.48	9.16	-99.63	37.	114.
RIGHT Y AXIS	-4.40	5.63	-27.67	58.	117.
RIGHT Z AXIS	-25.45	86.15	-109.65	45.	117.
RIGHT RESULTANT	32.98	150.71	2.22	117.	16.
SEAT FORCES (LB)					
LEFT X AXIS	8.40	129.63	-86.20	42.	53.
RIGHT X AXIS	-1.73	96.70	-225.63	33.	80.
X AXIS SUM	6.67	153.81	-237.06	42.	52.
Y AXIS	0.10	409.63	-4.41	57.	28.
LEFT Z AXIS	-3.92	936.62	-5.26	58.	0.
RIGHT Z AXIS	-4.49	455.94	-4.73	47.	0.
CENTER Z AXIS	43.00	6893.60	45.65	56.	0.
Z AXIS SUM	34.59	8185.14	35.66	57.	0.
RESULTANT	35.43	8195.85	35.66	57.	1.
Z SUM MINUS TARE	52.81	7683.50	38.84	57.	13.
RESULTANT MINUS TARE	53.36	7684.05	42.19	57.	2.
ADAM NECK FORCE (LB)					
X AXIS	-0.06	142.81	-79.09	62.	170.
Y AXIS	0.97	13.78	-36.87	63.	12.
Z AXIS	-11.00	566.52	-26.79	53.	125.
RESULTANT	11.07	575.90	0.09	53.	24.
ADAM NECK MY (IN-LB)	5.31	275.60	-214.69	150.	82.

SH STUDY TEST: 2340 SUBJ: ADAM-L WT: 216.0 NOM G: 20.0 CELL: D

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	4.51	13.63	-22.52	381.	56.
LOWER X AXIS	-3.10	18.61	-5.01	37.	394.
X AXIS SUM	1.41	28.51	-20.09	381.	57.
LAP FORCES (LB)					
LEFT X AXIS	-21.33	6.20	-106.28	38.	112.
LEFT Y AXIS	4.00	28.93	-12.61	111.	44.
LEFT Z AXIS	-35.83	41.19	-144.16	45.	114.
LEFT RESULTANT	41.90	181.15	5.44	115.	25.
RIGHT X AXIS	-27.32	4.58	-97.40	38.	115.
RIGHT Y AXIS	-1.22	11.23	-17.48	59.	114.
RIGHT Z AXIS	-29.75	58.74	-111.60	46.	117.
RIGHT RESULTANT	40.43	147.69	7.32	117.	17.
SEAT FORCES (LB)					
LEFT X AXIS	1.19	185.46	-91.08	44.	90.
RIGHT X AXIS	-4.25	101.88	-223.91	40.	52.
X AXIS SUM	-3.06	157.40	-292.47	42.	82.
Y AXIS	0.00	353.14	-1.08	57.	102.
LEFT Z AXIS	-6.09	745.39	-9.39	60.	13.
RIGHT Z AXIS	-3.93	615.48	-6.12	61.	1.
CENTER Z AXIS	58.69	6630.47	58.45	57.	0.
Z AXIS SUM	48.66	7868.04	46.11	57.	1.
RESULTANT	48.79	7876.29	46.55	57.	1.
Z SUM MINUS TARE	68.78	7393.60	55.91	57.	1.
RESULTANT MINUS TARE	68.87	7394.00	56.26	57.	1.
ADAM NECK FORCE (LB)					
X AXIS	-3.18	136.18	-91.80	62.	165.
Y AXIS	-0.24	10.68	-16.95	61.	97.
Z AXIS	-8.68	574.52	-24.16	53.	122.
RESULTANT	9.39	582.15	0.61	53.	329.
ADAM NECK MY (IN-LB)	13.28	289.57	-178.44	147.	83.

SH STUDY TEST: 2341 SUBJ: ADAM-L WT: 216.0 NOM G: 20.0 CELL: D

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	2.56	20.82	-23.91	378.	56.
LOWER X AXIS	-2.20	24.92	-3.68	378.	396.
X AXIS SUM	0.36	45.74	-18.89	378.	56.
LAP FORCES (LB)					
LEFT X AXIS	-0.53	22.15	-81.81	38.	111.
LEFT Y AXIS	0.11	27.20	-16.15	109.	44.
LEFT Z AXIS	-5.50	67.68	-100.25	44.	110.
LEFT RESULTANT	5.60	131.86	0.46	111.	167.
RIGHT X AXIS	-0.15	28.96	-59.42	38.	112.
RIGHT Y AXIS	1.22	8.20	-6.73	31.	44.
RIGHT Z AXIS	-1.91	68.88	-62.30	46.	113.
RIGHT RESULTANT	2.70	86.36	0.63	113.	1.
SEAT FORCES (LB)					
LEFT X AXIS	4.80	245.15	-76.35	61.	101.
RIGHT X AXIS	3.84	161.33	-243.89	39.	52.
X AXIS SUM	8.64	177.82	-224.69	40.	52.
Y AXIS	-15.42	263.46	-18.04	40.	0.
LEFT Z AXIS	-12.75	523.20	-12.75	56.	1.
RIGHT Z AXIS	-17.22	852.18	-18.68	61.	0.
CENTER Z AXIS	-188.27	6496.15	-188.76	57.	0.
Z AXIS SUM	-218.25	7726.37	-220.19	57.	1.
RESULTANT	219.01	7731.04	62.61	57.	314.
Z SUM MINUS TARE	-199.24	7263.87	-208.97	57.	1.
RESULTANT MINUS TARE	199.49	7264.60	61.30	57.	314.
ADAM NECK FORCE (LB)					
X AXIS	-1.98	147.55	-86.51	62.	168.
Y AXIS	1.25	14.18	-16.52	150.	98.
Z AXIS	-14.29	558.68	-26.58	53.	125.
RESULTANT	14.56	568.55	2.03	53.	25.
ADAM NECK MY (IN-LB)	2.29	260.00	-230.29	149.	84.

SH STUDY TEST: 2342 SUBJ: ADAM-L WT: 216.0 NOM G: 10.0 CELL: B

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	0.27	-0.04	-15.36	0.	51.
LOWER X AXIS	-1.06	12.47	-1.83	54.	8.
X AXIS SUM	-0.79	8.76	-16.56	54.	51.
LAP FORCES (LB)					
LEFT X AXIS	-20.47	0.44	-47.28	55.	160.
LEFT Y AXIS	3.70	13.00	-5.06	165.	48.
LEFT Z AXIS	-29.28	13.37	-59.50	53.	166.
LEFT RESULTANT	35.93	75.78	3.07	166.	37.
RIGHT X AXIS	-17.71	0.77	-40.02	46.	161.
RIGHT Y AXIS	0.64	4.57	-3.47	28.	169.
RIGHT Z AXIS	-19.22	18.29	-40.45	54.	159.
RIGHT RESULTANT	26.16	57.01	6.27	169.	25.
SEAT FORCES (LB)					
LEFT X AXIS	-4.81	98.05	-17.74	84.	8.
RIGHT X AXIS	-1.26	77.15	-155.39	61.	71.
X AXIS SUM	-6.07	73.98	-97.81	86.	71.
Y AXIS	-0.29	178.31	-5.84	61.	68.
LEFT Z AXIS	-5.71	362.04	-5.84	61.	0.
RIGHT Z AXIS	-4.19	372.27	-6.37	71.	1.
CENTER Z AXIS	42.67	2705.44	46.53	63.	0.
Z AXIS SUM	32.77	3247.18	34.32	63.	1.
RESULTANT	33.56	3250.05	37.26	63.	1.
Z SUM MINUS TARE	52.48	3060.18	40.04	63.	4.
RESULTANT MINUS TARE	52.96	3060.22	44.35	63.	4.
ADAM NECK FORCE (LB)					
X AXIS	-3.03	54.96	-57.51	70.	178.
Y AXIS	-0.86	8.35	-10.07	172.	103.
Z AXIS	-8.84	198.40	-11.01	73.	0.
RESULTANT	9.47	205.08	2.42	73.	24.
ADAM NECK MY (IN-LB)	7.14	141.14	-74.29	169.	103.

SH STUDY TEST: 2343 SUBJ: ADAM-L WT: 216.0 NOM G: 8.0 CELL: E

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	5.10	5.74	-7.75	18.	72.
LOWER X AXIS	-1.31	8.73	-1.84	58.	10.
X AXIS SUM	3.79	10.79	-6.48	58.	93.
LAP FORCES (LB)					
LEFT X AXIS	-22.54	-0.51	-24.37	89.	169.
LEFT Y AXIS	3.85	5.31	-5.53	0.	58.
LEFT Z AXIS	-30.12	10.65	-28.96	71.	0.
LEFT RESULTANT	37.82	38.22	3.51	173.	51.
RIGHT X AXIS	-27.25	-5.98	-44.51	62.	172.
RIGHT Y AXIS	2.25	5.17	-0.57	10.	54.
RIGHT Z AXIS	-20.48	16.64	-36.22	93.	181.
RIGHT RESULTANT	34.18	57.39	11.29	181.	36.
SEAT FORCES (LB)					
LEFT X AXIS	-4.42	127.27	-9.87	97.	139.
RIGHT X AXIS	-0.67	39.53	-80.19	24.	81.
X AXIS SUM	-5.09	134.60	-13.04	98.	454.
Y AXIS	-3.94	163.15	-2.23	74.	20.
LEFT Z AXIS	-7.71	195.99	-10.15	75.	3.
RIGHT Z AXIS	-5.83	328.15	-6.31	81.	0.
CENTER Z AXIS	38.96	2031.94	50.30	75.	0.
Z AXIS SUM	25.43	2467.73	33.84	75.	3.
RESULTANT	26.28	2474.00	33.85	75.	3.
Z SUM MINUS TARE	45.53	2337.39	45.05	75.	3.
RESULTANT MINUS TARE	45.83	2338.34	45.06	75.	3.
ADAM NECK FORCE (LB)					
X AXIS	-2.92	33.44	-39.52	82.	152.
Y AXIS	-748.45	70.55	-541.89	9.	0.
Z AXIS	-20.94	118.56	-21.05	85.	0.
RESULTANT	748.85	542.30	3.46	0.	267.
ADAM NECK MY (IN-LB)	-0.29	81.72	-37.14	160.	108.

SH STUDY TEST: 2344 SUBJ: ADAM-L WT: 216.0 NOM G: 8.0 CELL: E

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-1.83	1.83	-12.27	22.	55.
LOWER X AXIS	0.16	11.28	-1.16	58.	15.
X AXIS SUM	-1.67	5.64	-10.32	22.	55.
LAP FORCES (LB)					
LEFT X AXIS	-20.68	0.10	-39.10	59.	172.
LEFT Y AXIS	2.35	6.03	-4.80	160.	53.
LEFT Z AXIS	-27.54	11.94	-49.84	92.	172.
LEFT RESULTANT	34.53	63.63	2.98	172.	50.
RIGHT X AXIS	-22.01	2.31	-29.42	69.	162.
RIGHT Y AXIS	-3.07	2.85	-5.19	65.	180.
RIGHT Z AXIS	-25.87	23.53	-31.29	80.	173.
RIGHT RESULTANT	34.13	43.14	5.20	173.	37.
SEAT FORCES (LB)					
LEFT X AXIS	-10.22	95.57	-14.59	99.	6.
RIGHT X AXIS	-9.81	48.28	-57.63	72.	84.
X AXIS SUM	-20.04	87.63	-29.13	97.	132.
Y AXIS	0.12	169.06	-1.01	73.	129.
LEFT Z AXIS	-4.88	361.53	-6.34	74.	0.
RIGHT Z AXIS	-5.93	199.16	-9.09	68.	6.
CENTER Z AXIS	41.48	1925.20	43.90	75.	0.
Z AXIS SUM	30.67	2378.57	31.62	75.	0.
RESULTANT	36.78	2383.18	37.11	75.	0.
Z SUM MINUS TARE	49.53	2255.97	45.68	75.	0.
RESULTANT MINUS TARE	53.48	2256.53	49.64	75.	0.
ADAM NECK FORCE (LB)					
X AXIS	-0.46	39.64	-39.40	80.	178.
Y AXIS	-0.15	7.64	-6.17	160.	23.
Z AXIS	-14.54	121.45	-12.78	82.	0.
RESULTANT	14.60	127.84	0.66	84.	275.
ADAM NECK MY (IN-LB)	-3.30	96.13	-30.16	164.	93.

SH STUDY TEST: 2345 SUBJ: ADAM-L WT: 216.0 NOM G: 10.0 CELL: F

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	0.38	1.18	-12.30	25.	67.
LOWER X AXIS	-0.45	11.86	-0.57	55.	1.
X AXIS SUM	-0.08	7.52	-9.20	55.	32.
LAP FORCES (LB)					
LEFT X AXIS	-21.45	3.00	-39.61	56.	159.
LEFT Y AXIS	5.07	10.76	-3.69	162.	52.
LEFT Z AXIS	-31.50	15.90	-50.63	66.	166.
LEFT RESULTANT	38.46	63.95	5.24	165.	41.
RIGHT X AXIS	-21.31	3.44	-44.15	48.	165.
RIGHT Y AXIS	-4.95	2.11	-9.37	88.	151.
RIGHT Z AXIS	-31.29	15.62	-50.95	58.	157.
RIGHT RESULTANT	38.19	67.91	2.47	165.	31.
SEAT FORCES (LB)					
LEFT X AXIS	-9.47	58.50	-20.19	83.	11.
RIGHT X AXIS	-7.05	37.71	-31.36	87.	122.
X AXIS SUM	-16.52	79.35	-38.06	87.	122.
Y AXIS	-1.35	175.94	-2.35	65.	0.
LEFT Z AXIS	-5.78	326.96	-6.02	68.	1.
RIGHT Z AXIS	-3.28	309.10	-3.28	60.	0.
CENTER Z AXIS	49.51	2839.39	55.06	64.	0.
Z AXIS SUM	40.45	3336.17	45.76	64.	1.
RESULTANT	43.86	3340.82	49.34	64.	3.
Z SUM MINUS TARE	59.04	3193.20	57.66	64.	1.
RESULTANT MINUS TARE	61.41	3193.36	60.53	64.	3.
ADAM NECK FORCE (LB)					
X AXIS	-1.58	51.62	-51.74	71.	170.
Y AXIS	-0.89	1.47	-6.20	69.	134.
Z AXIS	-13.05	174.88	-13.05	75.	0.
RESULTANT	13.30	179.97	0.39	75.	440.
ADAM NECK MY (IN-LB)	4.48	131.34	-54.38	160.	101.

SH STUDY TEST: 2346 SUBJ: ADAM-L WT: 216.0 NOM G: 10.0 CELL: F

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-1.15	0.02	-13.46	24.	59.
LOWER X AXIS	0.19	12.43	0.00	56.	2.
X AXIS SUM	-0.96	8.17	-11.61	56.	53.
LAP FORCES (LB)					
LEFT X AXIS	-20.38	0.07	-49.36	48.	160.
LEFT Y AXIS	7.15	16.25	-1.81	163.	51.
LEFT Z AXIS	-29.21	16.13	-61.50	67.	158.
LEFT RESULTANT	36.33	80.17	5.26	160.	41.
RIGHT X AXIS	-19.77	5.08	-51.58	58.	159.
RIGHT Y AXIS	-3.57	2.43	-7.90	64.	152.
RIGHT Z AXIS	-29.32	23.77	-62.38	70.	167.
RIGHT RESULTANT	35.55	81.33	2.17	170.	31.
SEAT FORCES (LB)					
LEFT X AXIS	-6.51	77.54	-13.51	82.	8.
RIGHT X AXIS	-4.90	66.70	-123.25	31.	74.
X AXIS SUM	-11.40	89.05	-70.44	30.	74.
Y AXIS	-6.04	173.64	-8.16	64.	0.
LEFT Z AXIS	-5.73	247.36	-6.34	63.	0.
RIGHT Z AXIS	-2.77	385.58	-5.68	70.	1.
CENTER Z AXIS	45.56	2727.14	49.42	65.	0.
Z AXIS SUM	37.06	3230.70	37.40	65.	1.
RESULTANT	39.49	3234.56	42.24	65.	1.
Z SUM MINUS TARE	55.24	3082.18	49.35	65.	1.
RESULTANT MINUS TARE	56.57	3082.23	52.65	65.	1.
ADAM NECK FORCE (LB)					
X AXIS	0.00	54.72	-54.71	87.	169.
Y AXIS	-37.12	24.16	-193.80	5.	0.
Z AXIS	-13.24	169.94	-15.30	75.	0.
RESULTANT	45.02	194.40	1.39	0.	439.
ADAM NECK MY (IN-LB)	4.77	139.06	-61.51	163.	104.

SH STUDY TEST: 2347 SUBJ: ADAM-L WT: 216.0 NOM G: 15.0 CELL: G

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	1.46	6.90	-23.13	377.	52.
LOWER X AXIS	-1.18	15.53	-2.50	49.	385.
X AXIS SUM	0.27	15.69	-21.27	49.	52.
LAP FORCES (LB)					
LEFT X AXIS	-18.87	2.76	-70.52	50.	122.
LEFT Y AXIS	7.59	30.38	-3.94	123.	45.
LEFT Z AXIS	-27.54	29.37	-92.61	52.	126.
LEFT RESULTANT	34.26	119.86	5.29	127.	26.
RIGHT X AXIS	-22.01	6.66	-83.99	42.	130.
RIGHT Y AXIS	-1.50	8.04	-6.89	106.	46.
RIGHT Z AXIS	-31.75	39.94	-97.11	62.	127.
RIGHT RESULTANT	38.68	127.01	2.67	136.	25.
SEAT FORCES (LB)					
LEFT X AXIS	3.83	264.28	-57.22	67.	111.
RIGHT X AXIS	1.06	46.05	-142.75	29.	59.
X AXIS SUM	4.89	175.64	-78.29	68.	56.
Y AXIS	-3.72	191.11	-8.28	48.	54.
LEFT Z AXIS	-3.51	281.30	-4.12	55.	1.
RIGHT Z AXIS	-4.47	696.12	-4.35	69.	0.
CENTER Z AXIS	57.50	4696.37	62.09	65.	0.
Z AXIS SUM	49.51	5471.38	53.61	65.	1.
RESULTANT	50.15	5474.80	53.65	65.	1.
Z SUM MINUS TARE	67.24	5200.23	61.36	65.	5.
RESULTANT MINUS TARE	67.55	5202.07	62.80	65.	1.
ADAM NECK FORCE (LB)					
X AXIS	-2.11	94.11	-85.23	69.	156.
Y AXIS	-31.35	105.97	13.88	165.	7.
Z AXIS	-9.23	315.83	-27.81	60.	141.
RESULTANT	110.95	339.14	16.55	60.	8.
ADAM NECK MY (IN-LB)	5.85	215.28	-119.01	148.	87.

SH STUDY TEST: 2348 SUBJ: ADAM-L WT: 216.0 NOM G: 15.0 CELL: G

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-0.31	1.51	-24.84	169.	52.
LOWER X AXIS	0.59	18.50	-0.15	49.	172.
X AXIS SUM	0.28	17.56	-19.40	49.	52.
LAP FORCES (LB)					
LEFT X AXIS	-23.11	1.74	-83.48	41.	124.
LEFT Y AXIS	2.98	15.97	-7.51	131.	46.
LEFT Z AXIS	-31.33	29.12	-107.12	53.	132.
LEFT RESULTANT	39.06	135.51	5.34	132.	28.
RIGHT X AXIS	-22.36	4.49	-68.03	40.	132.
RIGHT Y AXIS	-6.98	2.16	-19.66	31.	134.
RIGHT Z AXIS	-31.14	44.99	-76.40	52.	131.
RIGHT RESULTANT	38.98	102.53	5.13	132.	27.
SEAT FORCES (LB)					
LEFT X AXIS	6.40	141.21	-31.90	75.	291.
RIGHT X AXIS	-7.48	112.82	-104.76	52.	90.
X AXIS SUM	-1.08	201.83	-95.84	67.	97.
Y AXIS	-3.49	315.58	-4.62	64.	402.
LEFT Z AXIS	-1.83	599.38	-3.17	60.	0.
RIGHT Z AXIS	-5.04	335.98	-7.95	55.	5.
CENTER Z AXIS	55.39	4914.22	54.18	65.	0.
Z AXIS SUM	48.52	5688.35	46.22	65.	0.
RESULTANT	48.90	5699.43	48.79	65.	0.
Z SUM MINUS TARE	66.48	5425.46	54.84	65.	5.
RESULTANT MINUS TARE	66.66	5428.34	56.35	65.	5.
ADAM NECK FORCE (LB)					
X AXIS	-1.11	97.34	-75.93	68.	160.
Y AXIS	244.48	322.64	0.31	22.	17.
Z AXIS	-8.49	297.36	-30.18	67.	141.
RESULTANT	244.64	426.89	3.34	68.	17.
ADAM NECK MY (IN-LB)	5.03	227.31	-106.98	153.	89.

SH STUDY TEST: [illegible]349 SUBJ: ADAM-L WT: 216.0 NOM G: 20.0 CELL: H

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	0.42	3.32	-27.32	140.	56.
LOWER X AXIS	0.53	23.72	-0.52	37.	147.
X AXIS SUM	0.95	20.24	-20.38	50.	56.
LAP FORCES (LB)					
LEFT X AXIS	-19.21	5.04	-95.51	38.	111.
LEFT Y AXIS	5.84	32.73	-8.81	108.	42.
LEFT Z AXIS	-29.24	42.04	-121.13	43.	115.
LEFT RESULTANT	35.49	156.66	3.92	115.	17.
RIGHT X AXIS	-23.21	10.61	-104.97	37.	111.
RIGHT Y AXIS	-3.05	3.31	-15.07	30.	115.
RIGHT Z AXIS	-31.77	59.05	-125.00	45.	117.
RIGHT RESULTANT	39.49	162.48	2.06	117.	16.
SEAT FORCES (LB)					
LEFT X AXIS	7.22	234.94	-69.70	60.	103.
RIGHT X AXIS	-1.27	128.24	-199.85	39.	52.
X AXIS SUM	5.95	167.66	-167.25	40.	52.
Y AXIS	-2.95	232.26	-53.93	39.	115.
LEFT Z AXIS	-4.94	481.98	-6.41	56.	1.
RIGHT Z AXIS	-2.77	1013.23	-2.77	61.	0.
CENTER Z AXIS	54.12	6596.23	49.29	57.	1.
Z AXIS SUM	46.40	7977.84	40.11	57.	1.
RESULTANT	47.03	7980.33	40.70	57.	1.
Z SUM MINUS TARE	65.27	7526.57	48.41	57.	13.
RESULTANT MINUS TARE	65.64	7526.86	51.76	57.	1.
ADAM NECK FORCE (LB)					
X AXIS	-2.34	127.55	-100.43	62.	155.
Y AXIS	480.77	638.99	46.51	324.	1.
Z AXIS	-9.75	448.51	-37.43	52.	123.
RESULTANT	480.88	769.49	47.80	52.	1.
ADAM NECK MY (IN-LB)	3.56	289.57	-178.44	145.	100.

SH STUDY TEST: 2350 SUBJ: ADAM-L WT: 216.0 NOM G: 20.0 CELL: H

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
HEADREST FORCES (LB)					
UPPER X AXIS	-3.02	28.68	-28.92	341.	55.
LOWER X AXIS	1.27	34.19	0.00	341.	121.
X AXIS SUM	-1.75	62.87	-20.23	341.	56.
LAP FORCES (LB)					
LEFT X AXIS	-18.86	10.57	-88.28	37.	108.
LEFT Y AXIS	6.18	32.58	-8.96	111.	44.
LEFT Z AXIS	-28.73	41.16	-112.51	44.	111.
LEFT RESULTANT	34.94	146.28	6.48	112.	18.
RIGHT X AXIS	-18.54	10.83	-77.55	37.	111.
RIGHT Y AXIS	-6.47	3.42	-17.25	59.	115.
RIGHT Z AXIS	-31.58	41.39	-99.58	46.	113.
RIGHT RESULTANT	37.20	127.39	2.39	115.	16.
SEAT FORCES (LB)					
LEFT X AXIS	10.71	138.51	-79.57	43.	100.
RIGHT X AXIS	-0.88	130.13	-285.45	39.	51.
X AXIS SUM	9.83	153.50	-300.94	40.	51.
Y AXIS	-0.28	240.26	-23.65	40.	120.
LEFT Z AXIS	-3.02	658.68	-4.12	59.	0.
RIGHT Z AXIS	-4.23	929.74	-4.23	59.	0.
CENTER Z AXIS	50.22	6479.21	51.42	54.	1.
Z AXIS SUM	42.96	7767.63	46.24	55.	1.
RESULTANT	44.18	7770.16	46.44	55.	1.
Z SUM MINUS TARE	61.51	7300.17	49.69	55.	2.
RESULTANT MINUS TARE	62.34	7301.04	50.14	55.	2.
ADAM NECK FORCE (LB)					
X AXIS	0.29	118.49	-85.17	60.	150.
Y AXIS	854.25	1282.55	23.91	12.	6.
Z AXIS	-9.19	542.31	-29.53	52.	123.
RESULTANT	854.30	1291.64	25.23	52.	6.
ADAM NECK MY (IN-LB)	-5.57	252.72	-185.57	143.	79.

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